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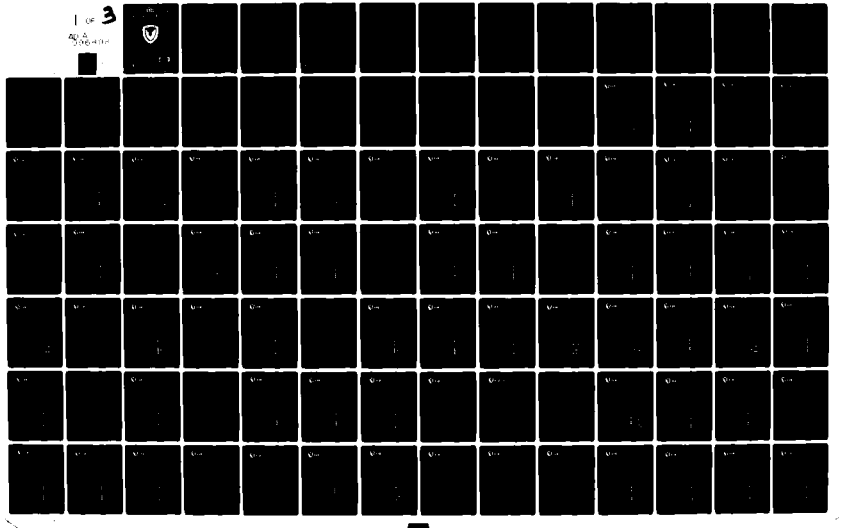

LEVEL II

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RELIABILITY, AVAILABILITY AND MAINTAINABILITY
DESIGN PRACTICES GUIDE

VOLUME 1

Prepared for
HEADQUARTERS, U.S. ARMY MATERIEL DEVELOPMENT
AND READINESS COMMAND, DRCQA-E
5001 EISENHOWER AVENUE
ALEXANDRIA, VIRGINIA 22333
under Contract DAAK80-80-C-0781

NOTE

This Guide describes specific problems encountered and solved by various designers, engineers and analysts. It is not all inclusive and does not relieve a designer of his obligation to thoroughly research and evaluate the various areas that affect his particular design.

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This guide compiles, in one source, selected real-world practices (techniques or tools) available to the Army engineer and manager to improve the reliability, availability, and maintainability (RAM) characteristics of equipment. It is the purpose of this guide to provide a medium for the exchange of experience and knowledge of DARCOM engineers, to minimize "re-inventing the wheel," and to provide a single compendium of techniques currently in use and available for adaptation to other systems and equipment. These techniques vary greatly in application, source, and theory.

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PREFACE TO FIRST UPDATE

This is the first update of the DARCOM RAM Design Practices Guide, which was originally published in August 1979. The new and revised entries represent contributions from Army RAM managers and engineers, Army R&D laboratory and analysis center personnel, and an extensive data search conducted by the DARCOM Product Assurance Directorate and contractor personnel. The data search made use of the computerized version of the Engineering Index (COMPENDEX), as well as Work Unit Summary and bibliography searches conducted by the Defense Technical Information Center (DTIC). While the overall data collection effort was extensive in both range and depth, it cannot be assumed that it was all-inclusive. Readers should not assume that the "best" design or analysis technique is included. The contributors have cited many worthy or notable approaches to solving specific analytic problems and design requirements. The technical approaches, articles, papers, and computer programs that have not been cited or "discovered" by the Guide's contributors are of primary concern to DARCOM. It is hoped that the reader will take time to periodically review the design, testing, and analysis techniques that he has encountered and will undertake the effort to prepare and submit material for inclusion in the future updates.

To promote the dissemination of the material included in the Guide, DARCOM has initiated several efforts: (1) to make the Guide available to all DoD activities and contractors, the Guide will be available from DTIC; (2) DARCOM is investigating the feasibility and desirability of "automating" the Guide and placing it into the DARCOM System 2000 or another suitable information management system; and (3) updates will occur on a more frequent basis -- whenever a sufficient number of changes or new entries are identified, they will be published in an update package to all individuals listed in the Guide's distribution list.

DARCOM believes that the RAM Design Practices Guide partially fills the need for a means to disseminate information concerning proven and practical RAM analysis, design, and testing techniques. User comments and contributions are vital in this endeavor and are earnestly solicited.

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APPENDIXES

RELIABILITY, AVAILABILITY, AND MAINTAINABILITY DESIGN PRACTICES GUIDE INTRODUCTION

1.1 PURPOSE

This Guide compiles, in one source, selected real-world practices (techniques or tools) available to the Army engineer and manager to improve the reliability, availability, and maintainability (RAM) characteristics of equipment. It is the purpose of this Guide to provide a medium for the exchange of experience and knowledge of DARCOM engineers, to minimize "re-inventing the wheel," and to provide a single compendium of techniques currently in use and available for adaptation to other systems and equipment. These techniques vary greatly in application, source, and theory.

The Guide presents pertinent information for each entry, including a brief description, information on previous applications, and point of contact for further information, if available. Full details concerning the application of the techniques must be obtained through the contact listed.

Selected RAM techniques that have been identified as having significant utility are listed. To be of continuing value, the Guide will be periodically updated to include new applications of old techniques and to identify new developments in this field. It is therefore important that new developments be identified and submitted by the users to DARCOM for incorporation.

1.2 WHAT IS RAM?

Reliability, availability, and maintainability are design traits of an equipment that characterize its ability to continue to perform its intended mission. This Guide assumes the following definitions:

- Reliability is the probability that a system will perform satisfactorily for at least a given period of time when used under stated conditions.
- Maintainability is the probability that a failed system will be restored to operable condition within a specific time.
- Availability is the probability that a system is operating satisfactorily at any point in time when used under stated conditions, where the total time considered includes operating time and active repair time.

1.3 DESIGNING WITH RAM

The RAM characteristics of equipment are inherent factors of equipment design; they reflect the techniques and materials available and used by the engineers and managers to achieve these characteristics. RAM characteristics must be considered throughout the life cycle to ensure achievement of RAM goals. The design process to achieve RAM objectives involves the selection and evaluation of goals, identification of where improvements are required, simulations and analysis to identify alternatives, and testing to evaluate achievement of RAM goals.

Initiation of an effective RAM program in the earliest states of development will enable the designer to continually evaluate the RAM characteristics of the design and to incorporate new technology and material to improve RAM.

1.4 INTRODUCTION TO SYNOPSES

The following section of this Guide contains synopses of various RAM design practices. The synopses are separated by key words into major categories and subcategories. The major category headings are Design Applications, Design, Models, Test, Analysis, and Contract Applications. These major categories are divided into subcategories as shown in Table 1. They contain various methods, practices, computer programs, policies, and design applications that can help improve the RAM characteristics of equipment. For ease of use, the categories and subcategories are separated by color-coordinated tab dividers.

The first category, Design Applications, is intended to provide information directly affecting hardware design. The following definition of Design Applications was used in this Guide:

> Those design practices, techniques, or innovations which the design engineer can apply to hardware to enhance or prevent deterioration of its RAM characteristics.

The other five categories present information on various methodologies useful to the design, reliability, or quality engineer or manager. These synopses were identified by using the following definition:

> Those evaluation tools or techniques available to the engineer and manager to improve the RAM characteristics of equipment.

Each synopsis includes key word category and subcategory; title; a brief description; pertinent data on previous applications, if any; and a point of contact, if available. These pertinent data are located in the table at the foot of each page, together with the phase of the life cycle to which it was applied in the previous application. The source of further information provided is the most recent available.

Table 1. CATEGORIES AND SUBCATEGORIES OF SYNOPSIS KEY WORDS

Category	Subcategory
Design Applications	Electrical Rotating Processes Fluid Systems Structural
Design	Failure Modes Fault Isolation Sneak Circuit Analysis Environment
Models	Reliability Reliability Growth Life Cycle Simulation Prediction
Test	Data Analysis Data Collection Reliability Environment Testing Technology
Analysis	Data Life Cycle Reliability Availability Maintainability
Contract Applications	Reliability Maintainability Reliability Improvement Warranty

This Guide will be periodically updated with RAM design practices from the users and other sources. Therefore, it is important and encouraged that when new tools and techniques-methodologies, practices, materials, or applications are developed, the users identify and submit these for inclusion in the Guide. To be applicable to this Guide, a technique should fall within the categories and definitions given in the first paragraph of this section. In general, it should have the following characteristics:

- Applicable to reliability, availability, or maintainability
- Available or accessible to DARCOM personnel
- On active status or in development

In addition, each new tool and technique submitted should have practical application and be relevant to Army systems and missions.

To submit information for inclusion in this guide, complete one of the blank synopsis forms contained in Appendix III of this Guide and send it to:

Headquarters, U.S. Army Materiel Development and Readiness Command
5001 Eisenhower Avenue
Alexandria, Virginia 22333
Attention: DRCQA-E

1.5 BIBLIOGRAPHY OF RAM INFORMATION

There are many sources of information on the theory and application of RAM. Inclusion and discussion of all such documents is beyond the scope of this document. A partial list of frequently referenced standards, directives, and other documents pertaining to RAM is presented in Appendixes I and II.

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Conductive Anodic Filaments; "17th Annual Proceedings Reliability Physics 1979," pp 51-63, CH 1425-8/79/000-0051

Synopsis:

A problem has been identified when using Conductive Anodic Filaments (CAFs) in high humidity environments. The problem is the building of growths emanating from the positively biased conductor. This growth can bridge across to the other conductor, causing a short.

A solution has been identified which is to use barrier coating compounds which inhibit the formation of the growths. Common waterproofing coatings do not prevent this problem.

PREVIOUS APPLICATION		
System	Equipment Type	Applicability
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Dr. D. Lando **Address:** Bell Laboratories Whippany, NJ **Telephone:** **Autovon** **Commercial** (201) 386-3000		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Electrosensitive Line Printer

Synopsis:

The impact type printer previously used on the AN/TPQ-36 system has been replaced with a high-speed, non-impact, electrosensitive printer manufactured by Datametrics. The new printer uses a dry electrosensitive printing technology which requires no toners or post-printing processing. The printing process involves the electrical removal of a white zinc oxide surface coating from a through-conductive, carbon impregnated paper and the exposure of the black carbon underlayer to form the printed characters. The process is silent and not temperature-dependent. The maximum attainable reliability of the electrosensitive printer is predicted to be 20,000 hours versus 6,700 hours for the impact printer.

PREVIOUS APPLICATION

System	Equipment Type	Applicability
Peripheral Line Printing	AN/TPQ-36	● Reliability ○ Availability ● Maintainability

Point of Contact

Name: Mr. H. Selby

Address: ERADCOM
Ft. Monmouth, NJ 07703

Telephone:
Autovon 996-5152
Commercial (201) 544-5152

Life Cycle Phase

○ Conception
○ Validation
● Full Scale Development
● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Rotary Transformer Design

Synopsis:

A high power rotary transformer (1 kW) was considered as a replacement for slip-rings in a future satellite. A study was conducted to determine the best electrical design taking into account mechanical limitations while maximizing efficiency. Ferrite was used in a configuration which can be ground by any good machine shop. A design procedure is described which provides the engineer with a rough estimate of size and weight of a near optimum transformer given the power level, frequency of operation, and material to be used.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. E. E. Landsman **Address:** Lincoln Lab Massachusetts Institute Tech. Lexington, MA **Telephone:** **Autovon** **Commercial** (617) 862-5500		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Reliability of Charge-Coupled Devices , NASA MCR-78752

Synopsis:

NASA study report MCR-78752[N78 29352] "Preliminary Study of the Reliability of Charge-Coupled Devices" addresses the design of imaging systems and the use of Charge-Coupled Devices (CCD). While only one commercially available device is analyzed, CCD principles and the theoretical basis for the reliability analysis are presented. This information should be of value to design engineers using or contemplating the use of CCD's and provides information which will assist in assuring proper use of CCD's.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Aubrey D. Smith **Address:** George C. Marshall Space Flight Ctr Code ATO1 Marshall Space Flight Ctr., AL 35812 **Telephone:** **Autovon** **Commercial** (202) 453-2224		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Reliable Inverter Systems

Synopsis:

NASA has designed an improved base drive for a paralleled inverter system which uses a feedback winding in each driver transformer to apply the same sampling of load current to the base drive of each power transistor. This arrangement protects the inverter system from damage by open circuits and allows the transistors to withstand short circuits until a protective fuse operates. The effects of unequal turn-on characteristics of the power transistors are also minimized by the base drive system.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: John C. Drane **Address:** NASA Resident Legal Office - JPL 4800 Oak Grove Drive Pasadena, CA 91103 **Telephone:** **Autovon** **Commercial** (213) 354-6420		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Gallium Arsenide Field Effect Transistor (GaAs FET) Amplifier Design

Synopsis:

Tunnel Diode Amplifiers (TDAs) were previously employed in EDM radars, and excessive gain variations were noticed when they were deployed in the field. Numerous failures occurred when using the TDAs. These problems were solved when the TDAs were replaced with the GaAs FET amplifiers. Amplifiers employing this new GaAs FET device installed in the EDM radar systems resulted in reliability increases to 5000 hours of trouble-free operation.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Amplifier	AN/TPQ-36	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. H. Selby **Address:** ERADCOM-PM Firefinder Fort Monmouth, NJ 07703 **Telephone:** **Autovon** 996-5152 **Commercial** (201) 544-5152		○ Conception ○ Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Corrosion Protector

Synopsis:

Corrosion protector vaporizes continuously to form a thin ionic film on exposed metal surfaces to prevent rust and corrosion. The device eliminates application of oil, grease, plating, paint, or paper to protect metal parts. The device is made of open-cell foam and is impregnated with granulated amine salts. The salts vaporize at room temperature and form a moisture-absorbing coating on all surfaces. The film does not alter any of the properties of the metal.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: **Address:** Cortec Corporation St. Paul, Minn. **Telephone:** **Autovon** **Commercial** (612) 224-5644		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Cable-Fault Locator

Synopsis:

A new fault locator system that has potential for Army application has been designed by NASA. The system will instantaneously detect a short circuit in an overhead or underground power cable and display the fault location at a remote monitoring station. This has a direct impact on the length of time required to locate the fault and will result in a significant reduction in the mean-time-to-repair power distribution networks. Further information is available through the point of contact.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Raymond J. Cerrato **Address:** John F. Kennedy Space Center Code SA-RTP Kennedy Space Center, FL 32899 **Telephone:** **Autovon** **Commercial** (305) 867-2780		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Aircraft Battery Conditioner/Analyzer

Synopsis:

A prototype Programmed Peak Charge (PPC) battery conditioner/analyzer system for nickel-cadmium batteries has been developed by the U.S. Army. The PPC system reduces water boil-off and over-temperature conditions and has fewer battery recycles and cell replacements. The PPC system employs constant current charging in contrast to the constant potential type of charging used in older systems.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Power	Batteries	● Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. Scharpf **Address:** AVRADCOM Applied Technology Laboratory Fort Eustis, VA 23604 **Telephone:** **Autovon** 927-5620 **Commercial** (804) 878-5620		○ Conception ○ Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Computerized Pattern Recognition Applied to Ni-Cd Cell Lifetime Prediction

Synopsis:

Computerized pattern recognition was used to look for characteristics of new nickel-cadmium spacecraft cells which would be predictive of later performance under stressful conditions. It was found that the changes in voltage while a cell was being charged could be used to make a rough estimate of its lifetime. The standard deviation in the predicted lifetime values was somewhat smaller than the standard deviation of the lifetime distribution as a whole, and there are indications that a more extensive data set would yield better results.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. W. Byers **Address:** Purdue University Dept. of Chemistry Lafayette, Indiana **Telephone:** **Autovon** **Commercial** (317) 494-8441		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Diagnostic Analyzer for Electric Forklift Trucks

Synopsis:

A forklift truck diagnostic analyzer has been designed that will allow troubleshooting of the electrical systems of all forklift trucks in the Army inventory and anticipated new designs. This system will provide improved accuracy and reduced maintenance troubleshooting time as well as standardization in equipment support requirements.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. Z. E. Spears **Address:** Western Technical Associates Los Angeles, CA **Telephone:** **Autovon** **Commercial** (213) 641-6260		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Patriot BITE

Synopsis:

The Patriot System, in recognition of the fact that fault isolation typically consumes more time than any other portion of the maintenance cycle, has incorporated an extensive amount of BITE (Built-In Test Equipment). BITE, working in conjunction with the Patriot computer program routine, will either isolate a discrete faulty assembly or localize the fault to a group of assemblies. The fault in the group of assemblies will then be isolated manually using a combination of substitution methods and/or test equipment which complement the equipment's BITE capability. This approach has permitted the operator to perform a number of the maintenance actions with limited training. Improved operational availability was also realized from reduced troubleshooting time and awaiting-parts time.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Missile	Patriot	○ Reliability ● Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. M. Wyatt **Address:** MIRADCOM - DRDMI-QRW Redstone Arsenal, AL 35809 **Telephone:** **Autovon** 746-5115 **Commercial** (205) 876-5115		○ Conception ○ Validation ○ Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Redundant Ring Structures for Shipboard Distributed Computer Systems

Synopsis:

The potential constraints on a ring structured distributed computing system imposed by the shipboard environment were evaluated. The feasibility of increasing distributed ring system availability to meet the requirements was investigated. It was shown that with a multiple linked ring structure, shipboard environmental effects would not severely degrade successful operation of a distributed system. This finding could result in the utilization of distributed ring computing systems with suitably redundant data path schemes as a highly reliable general purpose data processing system on shipboard platforms.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. P. Snyder **Address:** Naval Postgraduate School Monterey, California **Telephone:** **Autovon** 878-2411 **Commercial** (408) 646-2411		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Antenna Selection

Synopsis:

Use of a phased array antenna provides the advantages of a steerable antenna, but with fewer moving parts. Single and multiple beam capabilities allow continuous or discrete scanning of the antenna replacing multiple antennas with one. Reduced parts requirements, while providing increased capability, have shown to improve field reliability and decrease maintenance requirements over older, multiple antenna systems. This type of antenna is presently employed on the PATRIOT and FIREFINDER radars.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Antenna	PATRIOT FIREFINDER	● Reliability ● Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. M. Walker **Address:** MICOM Redstone Arsenal, AL 35809 **Telephone:** **Autovon** 746-7570 **Commercial** (205) 876-7570		● Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Satellite Calibration

Synopsis:

The assurance of data quality acquired by satellite sensors which are located hundreds of miles away, and accessible only after radio transmission and various other electronic or other manipulations, should not readily be taken for granted. The integration of information from multiple sources can often produce confusion. Ideally, one should be able to compare the observation from instrument A to instrument B, from satellite A to satellite Z, and from the first day in the operational life of the system to its last day. To assure this, total system calibration must include full life-cycle application of calibration techniques as most factors affecting equipment performance contain or produce time-dependent variables which affect system operation. Proper design of system calibration will help prevent loss of operation in future operation where repair is impossible.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. L. E. Williamson **Address:** Army Electronics Command White Sands Missile Range, NM **Telephone:** **Autovon** 258-1630 **Commercial** (505) 678-1630		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Parts Reduction

Synopsis:

The role of reliability has been significant in the design concept for the PATRIOT missile system. The result of the program has been that the PATRIOT satisfies performance and reliability requirements and has reduced support costs. In contrast to the multiple radars used by HAWK and HERCULES missile systems, the PATRIOT has gone to a single multi-function radar system. The PATRIOT parts reduction concept has improved its overall system reliability and has lowered support costs. The equipment parts reduction was achieved by replacing various discrete electronic components with standard solid-state modules.

PREVIOUS APPLICATION		
System	Equipment Type	Applicability
Missile	PATRIOT	● Reliability ○ Availability ○ Maintainability
Point of Contact		Life Cycle Phase
Name: Mr. M. Walker Address: MICOM Redstone Arsenal, AL 35809 Telephone: Autovon 746-7570 Commercial (205) 876-7570		○ Conception ○ Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: *Engineering* Design Handbook: Military Vehicle Electrical Systems; AD-783697

Synopsis:

The objectives of the handbook are (1) to collect diverse sources of information unique to combat and tactical vehicles in order to conserve time, materials, and money in the successful design of new equipment; (2) to provide guidance in capsule form for new personnel, armed forces contractors, or experienced design engineers in other fields who require information about vehicle electrical systems; (3) to supply current fundamental information; and (4) to place the reader in a position to use new information generated subsequent to the publication of this handbook. To meet these objectives, the handbook has been written to provide the necessary background regarding electrical equipment and systems so that more complete information and data available in the references can be used.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. J. Hess Mr. G. Newport **Address:** DARCOM-DRCQA-E Alexandria, VA **Telephone:** **Autovon** 284-8920 **Commercial** (301) 274-8920		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Maintainability Design of Digital Systems/Equipments

Synopsis:

The maintainability design tool developed during this study is an advanced maintainability design technique as applied to the design of self-repair fault-tolerant digital systems/equipments. The design tool is computerized and will allow the systems/equipments designer to simulate fault-tolerant configurations and alternatives of digital systems/equipments. Basically, the design tool is a compilation of a group of compatible programs which can be run on a large disk-operating system. The approach taken was one of modifying existing programs to the necessary extent and the writing of new programs where none existed. The SKC-2000 airborne computer design was used as a test vehicle for the products developed. The basic architecture of the computer was reconfigured in various fault-tolerant redundant schemes and evaluated for their Reliability, Availability, Maintainability (RAM) effects versus Life-Cycle Costs (LCC) at specified mission requirements.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. W. W. Gaertner **Address:** GAERTNER Research Inc. Stamford, CT **Telephone:** **Autovon** **Commercial** (203) 322-3673		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** August 1979

Title: Ground Electronic Maintainability Engineering Design Notebook; AD-A009043

Synopsis:

The RADC Maintainability Engineering Design Notebook (AD number A009043) brings together currently available knowledge of maintainability engineering and treats such knowledge from a practical rather than theoretical viewpoint. The notebook provides both quantitative and qualitative information and techniques which can serve as guidelines for those personnel who are directly responsible for establishing maintainability requirements and maintainability design, and for the acceptance of the maintainability of Air Force ground electronic systems and equipments. Although the notebook is directed at ground electronic systems, the majority of the material is applicable to a much broader class of hardware. Specifically, the notebook includes a description of the time phasing of the maintainability program tasks, a breakdown of maintainability into its roots, a detailed description, guidelines and methodology, procedures, and an example of each maintainability task, as applicable.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. L. R. Greenman **Address:** Martin Marietta Aerospace Co. Orlando, FL **Telephone:** **Autovon** **Commercial** (305) 352-2000		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** July 1980

Title: Reliability Influences from Electrical Overstress on LSI Devices; 18th Annual Proceedings, Reliability Physics, 1980, pp 190-204

Synopsis:

The findings of this paper indicate that ESD susceptibility increases with temperature for LSI MOS devices with junction diodes used for input protection. The implications of these results are as follows:

- Use of LSI MOS devices at elevated temperatures may create a greater susceptibility to ESD or electrical overstress than at room temperatures.
- Failure analysis techniques which rely on elevated temperatures (e.g., decap techniques which require elevated temperatures to ensure the proper chemical action) must ensure that proper ESD prevention procedures are utilized; otherwise, ESD failure modes may be induced during the failure analysis, thus producing erroneous results.
- Accelerated life tests using temperatures higher than 125°C may produce failure modes not normally seen at normal operating/ room temperatures.

(Continued)

PREVIOUS APPLICATION

Systems	Equipment Type	Applicability
Electronic	LSI	● Reliability ○ Availability ○ Maintainability

Point of Contact		Life Cycle Phase
Name:	Arthur Hart Tsuo-Tong Teng Arn McKenna	○ Conception ○ Validation ● Full Scale Development ● Production and Deployment
Address:	Corvallis Division Hewlett Packard Company 1000 N.E. Circle Boulevard Corvallis, OR 97330	
Telephone:		
Autovon		
Commercial	(503) 757-2000	

Title: Reliability Influences from Electrical Overstress on LSI Devices

Synopsis: (Continued)

- Increased susceptibility to ESD (e.g., handling hot boards) and electrical overstress (e.g., voltage spikes) damage may occur.

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** November 1980

Title: A Broad-Band Passive-Redundant UHF Amplifier Circuit; NRL Memorandum Report 3997; AD-A069325

Synopsis:

The Naval Research Laboratory had developed a passive-redundant amplifier circuit which does not contain a separate monitor circuit. The circuit development is part of NRL's maintenance-free radar development program.

The basic circuit consists of two amplifiers, one power splitter, one power canceller, one power combiner, one directional coupler, and phase-compensating circuits.

A laboratory model was constructed using off-the-shelf components. Simulated failures were inserted into the model. Results of these tests indicate that the circuit can perform fault detection and compensation, and maintain constant output in the event either amplifier fails completely or both amplifiers suffer graceful degradation. The output of the circuit varied $\pm$ 0.13 dB over the entire 400-470 MHz range.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: D.C. Rohlfs, R.E. Garback, B.N. Navid **Address:** Radar Techniques Branch, Radar Division, Naval Research Laboratory, Washington, D.C. 20375 **Telephone:** **Autovon** 297-3456/3547 **Commercial** (202) 767-3456/3547		● Conception ● Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical, DESIGN/ Analysis

Date: November 1980

Title: Broadband GaAs MESFET Power Amplifier Design Aspects; NRL Report 8334; AD-A075692

Synopsis:

This report presents design aspects of ultra-wideband GaAs MESFET power amplifiers which are directed to ECM and EW system applications. Fundamental gain bandwidth limitations are derived for state-of-the-art GaAs MESFET power devices. Broadband designs are developed in the 2 to 18 GHz range using analytical and computer-aided optimization techniques. These designs are based upon small and large signal device characterization and modeling. Presented are systematic procedures required to arrive at the final designs. Modeling techniques and their utilization as a tool in achieving optimum performance are described. Included in this report is a discussion of the laboratory methods employed to perform small and large signal device characterization and analysis. (Author)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
ECMP/EW	Power Amplifier	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: H. A. Willeny, W. H. Ku* **Address:** Microwave Technology Branch Electronics Technology Division Naval Research Laboratory **Telephone:** Washington, D.C. 20375 **Autovon** 297-3312 **Commercial** (202) 767-3312		● Conception ● Validation ● Full Scale Development ○ Production and Deployment

*Electrical Engineering Department, Cornell University, Ithaca, NY 14853

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATION/Electrical, DESIGN/Fault Isolation **Date:** November 1980

Title: A Phased Array Maintenance Monitoring System, Parts I and II; NRL Memorandum Reports 3613 and 3737; AD-A049063 and AD-A053396

Synopsis:

NRL developed several methods to detect and isolate failures in a linear phased array and in a COMPACT array ("cost minimized phased array circuit technique," which produces sector element patterns from a linear array while reducing the number of element parts by a factor of 2). The methods are adaptable to planar arrays.

All methods use an RF sampling manifold located at the radiating aperature. The following methods were developed:

- Linear Array
  - .. Balanced monitoring system
  - .. Fourier transform system

(Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Radar	FAA Time Reference Scaning Beam, Microwave Landing System	○ Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: J. K. Hsiao and J. P. Shelton **Address:** Target Characteristics Branch Radar Division Naval Research Laboratory **Telephone:** Washington, D.C. 20375 **Autovon** 297-3406 **Commercial** (202) 767-3406		● Conception ● Validation ● Full Scale Development ○ Production and Deployment

Title: A Phased Array Maintenance Monitoring System, Parts I and II; NRL Memorandum Reports 3613 and 3737; AD-A049063 and AD-A053396

Synopsis: (Continued)

. COMPACT

.. Fourier transform system

.. Hadamard transformation system

Results of computer simulations of the methods are furnished in the reports.

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** December 1980

Title: A New Approach to the Design of Highly Efficient Regulated DC to DC Converters; HDL-TR-79-29; AD-A078627

Synopsis:

This report describes a novel approach to the design of efficient, switching regulated dc-to-dc converters whereby an energy storage inductor and a commutating diode are in the output transformer primary circuit of the converter. This design has advantages of simplicity, economy, and reliability in applications where high-output voltages, multiple-output voltages, or both are involved. (Author)

Five 30 W converters were built and tested at room temperature. One breadboarded converter was tested over a temperature range of -40 to +75°C. The efficiency of the constructed power supply was over 80 percent. This high efficiency permitted the use of small TO-5 switching transistors, eliminated the need for a series-pass transistor, and reduced the required space and generated heat.

A schematic of the 30 W converter is provided in the referenced report.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Electronic	DC-to-DC Converters	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Philip M. Cowett, Jr. **Address:** Harry Diamond Laboratories 2800 Powder Mill Road Adelphi, MD 20783 **Telephone:** **Autovon** 290-1600 **Commercial** (202) 394-1600		● Conception ● Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** November 1980

Title: Packages for Microstrip Integrated Circuits; Manufacturing Methods and Technology Project Summary Report (CRCS DRCMT-302), June 1980, pp 41-43.

Synopsis:

Microstrip integrated circuits (MICs) are typically utilized in military electronics, have a resultant low applicability, and non-standard configuration (package). The AN/PPS-15 uses numerous MIC and was therefore considered a candidate for a packaging standardization program.

The program's design considerations were as follows:

- Packaging
- Welding
- Hermetic Sealing
- Repairability

Standard packages were developed for 2"X4", 1"X1", and 1"X2" substate areas. The package dimensions were selected based upon production tolerances and the electrical performance of available connectors.

A production yield was obtained of over 97 percent. The primary (Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Electronic	Microstrip IC's	● Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: James Kelly **Address:** U.S. Army Electronics Research and Development Command Fort Monmouth, N.J. ***Telephone:*** **Autovon** 995-4803 **Commercial** (201) 545-4803		● Conception ● Validation ● Full Scale Development ● Production and Deployment

Title: Packages for Microstrip Integrated Circuits

Synopsis: (Continued)

failure mode was contaminated, nonrepairable welds. Units were readily opened for repair and resealed using TIG welding. Hermeticity leakage rates of less than $1X10^{-8}$ atm cc/sec were achieved on the majority of units.

Since there are no standard microwave integrated circuits, the packages were not used in the production AN/PPS-15. The benefits of the program were as follows:

- Improved hermeticity of RF connectors
- Use of TIG welding in the production process

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** December 1980

Title: High Temperature Electronics

Synopsis:

The Naval Research Laboratory has initiated a program to identify and develop generic families of electronic components which are reliably operable when subject to operating temperatures on the order of 300°C. Current military electronic components are typically rated for 85° to 100°C, maximum operating temperature. While the current objective is to develop an electronic, gas turbine fuel control which can operate without "external" cooling, the results of the project should be applicable to any system in which the electronics must be cooled for reliable operation.

A publication which has been generated in conjunction with this project is:

"High Temperature Electronics Technology - Phase 1 Final Report"
General Electric Report R80AEG212, March 1980
R. E. Anderson, W. C. Morris, R. P. Wagner

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Electronics	Fuel Control	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Dr. J. E. Davey **Address:** Naval Research Laboratory Attn: 6810 Washington, D.C. 20375 **Telephone:** **Autovon** 297-7524 **Commercial** (202) 767-7524		● Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** December 1980

Title: Multiband Microstrip Antenna; NASA Tech Briefs, Spring 1980, Vol 5. No. 1, MSC 18334

Synopsis:

NASA has developed a broadband, elliptically polarized antenna which consists of a stack of elliptical lamina of electrically conducting material separated by a dielectric material.

The frequency band of each element is determined by the dimension of the semimajor axis of the elliptical element. Each element is joined to the ground plane by an insulated pin at the center of the element. The highest frequency element is fed directly by the connector with the other elements being capacitively coupled through the smallest element.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Electronic	UHF Microwave	● Reliability ● Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: J. T. Wheeler **Address:** Lyndon B. Johnson Space Center Code AT3 Houston, TX 77058 **Telephone:** **Autovon** **Commercial** (713) 483-3809		● Conception ● Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Electrical **Date:** December 1980

Title: Conformal Coatings for Serviced Printed Circuit Boards; NADC-79265-60; AD-B048451

Synopsis:

Conformal coatings are applied to electronic printed circuit boards to prevent corrosion. During repair, the coating must be removed. The Navy realized that in many instances either the coating was not "patched" or an improper coating was applied. This situation was a result of a lack of conformal coating standardization, a lack of written instructions, and no standardization between fleet activities. The Naval Air Development Center was assigned the responsibility to identify suitable coatings and develop standard application procedures.

Hysol PC18M and Conathane CE-1164 passed all tests; however, according to OSHA data sheets, these materials have toxic effects. Dow 96-005 and Dow 3140 RTV were not included in the tests since these materials are incompatible with underlying expoxy, acrylic, and polyurethane materials; however, these materials should be used to recoat initial coatings which are silicone based. Humiseal 1B73 passed all tests, and NADC recommended that this material be used at all activities for recoating boards with initial acrylic, expoxy, polyurethane, or paraxylyene coatings.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Electronic		● Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: C. R. Hegedus **Address:** Aircraft and Crew Systems Technology Directorate, Naval Air Development Center, Warminster, PA 18974 **Telephone:** **Autovon** 441-3016 **Commercial** (215) 441-3016		○ Conception ○ Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Rotating **Date:** August 1979

Title: Bearing Heat Reduction

Synopsis:

A new method has been developed for reducing the heat generated in high-speed bearings operating in a vacuum, thus improving bearing life. The method utilizes a heat pipe with water as the working fluid and has shown to be superior even to copper rods. While other methods were researched to solve this problem, the heat pipe was found to be the most feasible and the most efficient.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Space Systems	Bearings	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. J. Samos **Address:** Langley Research Center Hampton, VA 23665 **Telephone:** **Autovon** **Commercial** (804) 827-3281		○ Conception ○ Validation ○ Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Rotating **Date:** August 1979

Title: Active Magnetic Bearings

Synopsis:

Using advanced electronic control, magnetic bearings are now capable of suspending shafts weighing up to 1100 kg at speeds up to 10,000 RPM. The use of magnetic bearings eliminates wear problems on precision bearings, vastly extending operational life as well as providing exceptional accuracies as low as 0.5 μM. Maintenance-free designs are also operational in limited quantities, eliminating high maintenance times associated with conventional bearings and lubrications.

PREVIOUS APPLICATION		
System	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. H. Habermann **Address:** Societe de Mecanique Magnetique Vernon, France **Telephone:** **Autovon** **Commercial**		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Rotating **Date:** August 1979

Title: Boundary-Lubricated Sleeve Bearings

Synopsis:

Improved operational life has been experienced when using boundary-lubricated sleeve bearings in heavily loaded, slowly moving joints of fixed and mobile structures. Substantial space savings have also been realized over the previously used hydrodynamic bearings. The current range of conditions under which these bearings become a good choice is greater than 3000 psi and 5 to 60 fpm.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. W. A. Glaeser **Address:** Battelle Columbus Labs. Columbus, Ohio **Telephone:** **Autovon** **Commercial** (614) 424-6424		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Rotating **Date:** August 1979

Title: Design Criteria for Elastomeric Bearings

Synopsis:

Elastomeric bearings for helicopter rotor head applications were investigated at AVRADCOM's Applied Technology Laboratory. The type of bearings considered were axially laminated cylindrical, radially laminated cylindrical, and spherically laminated. The study produced a computer program user's manual and a design manual for elastomeric bearings. The program user's manual describes the use and input of a program that performs a stress analysis on an axisymmetric body with isotropic materials. It also contains an accumulation routine to process the harmonics of a Fourier expansion solution as required in asymmetrically loaded bodies. The design manual contains recommended analytical approaches and engineering procedures for designing elastomeric bearings in helicopter rotor systems. The use of elastomeric bearings in helicopter rotor heads provides for improved rotor system loading and life characteristics, thereby reducing the helicopter's maintenance costs and improving its operational characteristics.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Helicopter	Rotors	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. Scharpf **Address:** AVRADCOM Applied Technology Laboratory Fort Eustis, VA 23604 **Telephone:** **Autovon** 927-5620 **Commercial** (804) 878-5620		● Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Rotating **Date:** August 1979

Title: Reliability Approach to Rotating-Component Design; NASA Technical Note TND-7846

Synopsis:

Lewis Research Center has developed a design-by-reliability methodology for rotating mechanical components that statistically matches the selected material strength to the imposed stresses. Analytical and experimental methods have been developed to match materials and loads in this way.

With the proposed method a smaller, lower weight shaft can result for a specified life and reliability than that with conventional methods.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Vincent R. Lalli **Address:** Lewis Research Center (NASA) Cleveland, OH 44135 **Telephone:** **Autovon** **Commercial** (216) 433-4000		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Rotating **Date:** August 1979

Title: RAM Considerations for Up-Powering a Reciprocating Engine

Synopsis:

Research has been conducted to determine the effect on equipment reliability when raising the performance capability of an engine through modification. TARADCOM has modified engines for higher horsepower capability. In up-powering the engines, three items were analyzed:

- Increased complexity from added components
- Stress-load temperature effect on engine components
- Applied load duty cycle

Results showed an appreciable degradation in the engine's RAM characteristics due to higher parts failures caused by several factors:

- The failure mode of added components
- Increased stress levels from higher operating speed and more heat dissipation

(Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Engines	LD-465 AVDS 1790-2A	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: W.A. Smith **Address:** TACOM Product Assurance Directorate Warren, Miss. 48090 **Telephone:** **Autovon** 273-2862 **Commercial** (313) 573-2862		○ Conception ○ Validation ○ Full Scale Development ● Production and Deployment

Title: RAM Considerations for Up-Powering a Reciprocating Engine

Synopsis: (Continued)

. Higher load duty cycle effects

As a result of this work, generic indices or "K" factors associated with the modification were then evolved to establish a technical basis for management decisions regarding system changes and their effects on RAM. While this technique does not necessarily improve an engine's RAM performance, the results provide a means for informed management to make decisions and provide areas for future investigation to improve the design of engines.

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Rotating **Date:** August 1979

Title: Analysis of Factors Affecting Turbine Engine Reliability; USAAMDRL TR-73-28

Synopsis:

The RAM problems of gas turbine engines were investigated at AVRADCOM's Applied Technology Laboratory. The study examined the factors that contribute to the RAM problems on current turbine engines. Among them are operational environment, engine operating speed, maintenance philosophy, engine loads, and operating cycle. Potential remedial actions which could improve future RAM characteristics were identified. Detailed work sheets on the procedures and the corrective actions can be found in the USAAMRDL TR-73-28 report. The study provides a complete assessment of U. S. Army aircraft engine RAM experience and the factors that must be considered in achieving significant RAM improvement.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Turbine Engine	T53, T55	● Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. Scharpf **Address:** AVRADCOM Applied Technology Laboratory Fort Eustis, VA 23604 **Telephone:** **Autovon** 927-5620 **Commercial** (804) 878-5620		● Conception ● Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Rotating **Date:** August 1979

Title: Improved Transmission Cooling

Synopsis:

Cooling of helicopter tail rotor and intermediate transmissions has been improved by providing internal cooling fins in the transmission housing. Improving the convective heat transfer between the oil and the housing reduced the stabilized gearbox temperatures. Lower operating temperatures are expected to proportionally improve transmission reliability.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Mechanical	Transmission	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. Scharpf **Address:** AVRADCOM Applied Technology Laboratory Ft. Eustis, VA 23604 **Telephone:** **Autovon** 927-5620 **Commercial** (804) 878-5620		● Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Rotating **Date:** August 1979

Title: Development Program for Field-Repairable/Expendable Main Rotor Blades

Synopsis:

A new helicopter main rotor blade design and repair kit concept was investigated in an attempt to reduce blade-related helicopter costs. The blade design was aimed at making the rotor blade: (1) highly repairable to offset damage-related repair and minimize repair time, (2) survivable to minimize repairs, and (3) inexpensive so it can be economically discarded in case of severe damage. The blade design involves a bonded field-replaceable rotor blade pocket concept. The repair kit contains a bonding fixture tool for use in field repair of the blades. An instruction manual for the repair procedures was also prepared. Both the initial and life-cycle costs are predicted to be lower for the new blade design than for those blades now in use. The repair methods developed may be applied to other new blade designs, including metal skin and honeycomb sandwich blade constructions. The main blade concept investigated here was tested on the *UH-1D/H and CH-54B helicopters.*

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Helicopter Rotor Blade	CH-54B UH-1D/H	○ Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. Scharpf **Address:** AVRADCOM Applied Technology Laboratory Fort Eustis, VA 23604 **Telephone:** **Autovon** 927-5620 **Commercial** (804) 878-5620		○ Conception ○ Validation ○ Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Rotating **Date:** August 1979

Title: Helicopter Drive System On-Condition Maintenance Capability; AD-A028032

Synopsis:

The capability of main transmissions, intermediate gearboxes, tail rotor gearboxes, main rotor hubs, and swashplates on the UH-1 and AH-1 to operate with no scheduled overhaul periods was evaluated and documented in report AD-A028032. Overhaul and accident records, inspection procedures and the functional capability of the caution and warning subsystem and its condition-monitoring devices were examined; and failure mode, effects, and criticality analyses were performed to determine if any part or assembly failure modes would limit on-condition maintenance capability. It was concluded that UH-1/AH-1 helicopter drive system components have a capability for replacement and that overhaul intervals could be extended for some components or eliminated for others. This maintenance policy can also be extended to other systems.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Helicopter	UH-1 AH-1	○ Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. G. E. Knudsen **Address:** Bell Helicopter Co. Fort Worth, TX **Telephone:** *Autovon* **Commercial** (817) 280-2011		○ Conception ○ Validation ○ Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Rotating **Date:** August 1979

Title: Helicopter Drive System R and M Design Guide ; AD-A069835

Synopsis:

This document (AD number A069835) is a reliability and maintainability design guide for helicopter drive systems. While not containing 'how to' design information, the guide points out those areas of design which can be troublesome in the reliability and maintainability of helicopter drive systems. Besides containing information on the various drive system components, a management section is included that outlines some practices which design managers may employ to ensure that reliability and maintainability are given proper emphasis during a design program. The final section is devoted to a step-by-step procedure for hazard function analysis, which may be used to predict the reliability of a gearbox during the design stage.

PREVIOUS APPLICATION		
System	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. K. R. Cormier **Address:** United Technologies Corp. Stratford, CT **Telephone:** **Autovon** **Commercial** (203) 386-4000		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Rotating **Date:** August 1979

Title: Helicopter Drive System R&M Design Guide

Synopsis:

The Helicopter Drive System R&M Design Guide program is an investigation of the present state of transmission reliability and how reliability and maintainability are dealt with during the design and development of a helicopter drive system. The effort includes a study of the effect of quality control on drive system reliability, drive system maintainability problems, diagnostics, and the likely effect of advanced design concepts on the reliability and maintainability of future drive systems. The two types of reliability prediction techniques used in the investigation were hazard function analysis and probabilistic design. These two distinct methods can be useful in predicting reliability during the design stage of a helicopter drive system.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Helicopter Drive	AH-1 OH-6 CH-47 OH-58 CH-54 UH-1	● Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. Scharpf **Address:** AVRADCOM Applied Technology Laboratory Fort Eustis, VA 23604 **Telephone:** **Autovon** 927-5620 **Commercial** (804) 878-5620		● Conception ● Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Rotating **Date:** August 1979

Title: U. S. Army Helicopter Electrical System Reliability and Maintainability Investigation, Supplemental Design Guide

Synopsis:

This volume is a result of the investigation performed which identified deficiencies in military specifications and standards that affect U.S. Army helicopters. The volume provides supplementary information to each deficient document relating to design requirements, qualification testing, and quality assurance. The supplementary information to offset the most prevalent deficiencies were addressed to helicopter mission design requirements, which relate to environmental conditions, reliability and maintainability programs, and safety. Environmental testing and reliability and maintainability requirements were also addressed. This supplementary information may be used for future helicopter procurement purposes or may eventually be incorporated into existing aircraft electrical systems' documents.

PREVIOUS APPLICATION		
System	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. C. E. Nord **Address:** Systems Associates, Inc. Long Beach, CA **Telephone:** **Autovon** **Commercial** (213) 435-8282		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Rotating **Date:** September 1980

Title: R&M Investigation of Advanced Rotor System Concepts

Synopsis:

The Army is currently investigating several advanced helicopter rotor system concepts. These concepts are expected to provide significant improvements in aerodynamic performance, as well as improved R&M. The concepts assessed to date have demonstrated improved flight performance. However, little effort in the past has been expended to investigate and assess the R&M performance of these concepts. ATL has initiated an R&M program in this area. This program consists of the following tasks:

1. Quantitative assessment (MTBF, MTTR, etc.)
2. FMECA
3. Structural material assessment (characterization of material's stress, corrosion, cracking, and fatigue properties)
4. Maintainability assessment (repair/inspection complexity, schedule maintenance requirements, component replacement, required skill levels, etc.)
5. Vulnerability analysis (repair deferrability, combat maintenance techniques, etc.)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Helicopter	Advanced rotor blades	● Reliability ● Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Robert Hall **Address:** USAAVRADCOM Applied Technology Laboratory Ft. Eustis, Virginia 23604 **Telephone:** **Autovon** 927-5620 **Commercial** (804) 878-5620		● Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Rotating/Structural, DESIGN/Analyses

Date: August 1980

Title: Design Criteria for Dry Lubricated Flight Control Bearings; AVRADCOM USARTL-TR-79-17; DLSIE LD# 44482A

Synopsis:

The objective of the reported study was to develop wear equations to predict the life of dry lubricated helicopter flight control bearings. These equations would be used to select bearings for specific conditions of use (e.g., static radial load, cyclic radial load, speed of ball oscillator). Wear performance was measured as a function of radial clearance.

The test methods and analytical methods use in the study are presented in the cited report.

Major conclusions were as follows:

- Major contributions to linear wear were water interacting with time, water interacting with cyclic radial pressure, static radial pressure, maximum absolute value of PV.
- Wear predictions were poor for the very short lives when water is present.

(Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Edward J. Nagy **Address:** Kaman Aerospace Corporation Old Windsor Road Bloomfield, Connecticut 06002 **Telephone:** **Autovon** **Commercial** (203) 242-4461		○ Conception ○ Validation ● Full Scale Development ● Production and Deployment

Title: Design Criteria for Dry Lubricated Flight Control Bearings

Synopsis: (Continued)

- Wear life is not affected by the sequence of a duty cycle.
- Interference fit had no significant effect on wear results.

The report states several recommendations, as follows:

- Additional testing to improve reliability of the equations
- Additional testing of bearings of other sizes and from different manufacturers
- Testing with out-of-plane motion
- More testing with water; combination of water, sand and dust; oil with sand/dust
- Consider programmable/automated testing
- Effect of different test rigs evaluated
- Bearing material should be made less sensitive to water or water should be excluded from the ball-liner/wear interface by a seal.
- Additional continuous rotation test should be performed with lower energy input levels in order to prove or disprove the low-cost approach to evaluating bearing capacity. Additional test to find out if total wear is independent of the sequence of a series of sequential wear conditions.
- Sample in Appendix E was not large enough to support finding that size effects and manufacturing source do not affect wear life. Appendix E shows no size effect in wear life caused by water and wear life caused by sand and dust, whereas this study does. More testing to be performed to expand the sample of Appendix E.

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Rotating **Date:** November 1980

Title: Aircraft Gearbox Spline Lubrication; NADC-76393-30; AD-B020468

Synopsis:

NADC developed an improved grease formulation (designated 19S) with the following formulation:

64.22%	Synthetic hydrocarbon fluid
15.00%	Azealate di-ester (di 2-ethyl hexyl) fluid
5.52%	Tricresyl phosphate
5.00%	Molybdenum disulfide
0.42%	4,4' methylene bis 2,6 di-tert butyl phenol
0.84%	Tert butyl phosphate
6.00%	Bentone 27
3.00%	AR-155

This grease exhibited the following characteristics:

Work penetration 300

(Continued)

PREVIOUS APPLICATION

Systems	Equipment Type	Applicability
Aircraft	Gearbox Splines	● Reliability ○ Availability ○ Maintainability

Point of Contact	Life Cycle Phase
Name: E. Jewell **Address:** Naval Air Development Center Warminster, PA 18974 **Telephone:** **Autovon** 441-2567 **Commercial** (215) 441-2567	○ Conception ○ Validation ● Full Scale Development ● Production and Deployment

Title: Aircraft Gearbox Spline Lubrication, NADC-76393-30, AD-B020468

Synopsis (Continued)

Dropping point	400°F (204°C)
Evaporation at 350°F (177°C), 30 hours	15%
4 ball wear test (wear scar)	0.60mm
Rubberswell	20%
Splinewear (induction point)	140 hours
Load wear index	55
Oil separation	10%

This grease was tested on a type N-1 spline wear tester. MIL-G-81322 grease was used as a baseline for wear comparison. The induction period for the spline using MIL-G-81322 was 96 hours versus 140+ hours for the 19S greased spline.

Also, as part of this study, NADC investigated the use of ferrofluidized lubricants. Samples of MIL-G-81322 grease, MIL-G-81827 grease, and MIL-G-81322 base fluid were provided to the Ferrofluidics Corporation. These lubricants were magnetized to a saturation of 200 gauss.

To utilize the ferrofluidized greases, a magnetic circuit must be designed into the spline. Female splines were modified to incorporate a ceramic ring magnet. Results were inconclusive. First, the location of the magnet had the tendency to pull the lubricant from the spline. The ceramic magnet also had a tendency to break filling the spline with particles. Induction periods for the ferrofluidized grease were shorter than exhibited for plain MIL-G-81322. This lower induction period may result from the location of the magnet, the particles of broken ceramic magnet left in the spline after "repairs", or the result of wear caused by the suspended magnetic particles of the grease.

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Processes **Date:** August 1979

Title: Corrosion Prevention, Material Selection

Synopsis:

To minimize corrosion problems, the design engineer should select material carefully. For example, proper protective coatings such as epoxy primer/urethane paints provide excellent corrosion protection when chosen carefully and maintained properly. Alkyd paints promote corrosion by ultraviolet degeneration of the paint. Also, improper use of dissimilar metals in contact establishes a galvanic cell which corrodes one of the metals. Galvanic corrosion can only be prevented through proper design attention. In addition, engineers should carefully select alloys and other materials for their inherent characteristics, i.e., their reaction to heat treatment.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
All		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. L. Gilbert **Address:** U.S. Army Armament Material Readiness Command-DRSAR-LEC Rock Island, Ill. 61299 **Telephone:** **Autovon** 793-3298/6742 **Commercial** (309) 794-3298/6742		● Conception ● Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Processes **Date:** August 1979

Title: Corrosion Prevention, Entrapment

Synopsis:

Proper design of equipment should allow for drainage of trapped moisture and prevent condensation on critical surfaces. Examples of proper design include avoiding crevices that concentrate water or other fluids, providing for drainage in low areas, mounting printed circuit boards vertically, and not locating cables or wires in low areas.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
All		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. L. Gilbert **Address:** U.S. Army Armament Material Readiness Command-DRSAR-LEC Rock Island, Ill. 61299 **Telephone:** **Autovon** 793-3298 **Commercial** (309) 794-3298		● Conception ● Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Processes **Date:** August 1979

Title: Nondestructive Testing of Artillery and Tank Projectiles

Synopsis:

Various Nondestructive Testing techniques are currently applied to several large caliber projectiles to identify defects. These techniques are Visual, Magnetic Particle, Ultrasonic, Eddy Current, Hydrostatic, and Liquid Penetrant. Several other techniques are under investigation for possible application. These techniques are generally used during manufacturing to identify wear or defective pieces and improve the overall reliability of fielded shells.

PREVIOUS APPLICATION		
System	**Equipment Type**	**Applicability**
Projectiles	Various	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. L. G. Baker **Address:** ARADCOM Product Assurance Directorate Dover, NJ 07801 **Telephone:** **Autovon** 880-6741 **Commercial** (201) 328-6741		○ Conception ○ Validation ○ Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Processes **Date:** August 1979

Title: Reliability of Nondestructive Inspections; AD-A072097

Synopsis:

The results of a four-year Air Force Logistics Command program to determine the reliability of Air Force nondestructive inspection capability are presented in report AD-A072097. The report completely describes the program - its objectives, scope, planning and logistics, participants, data collection, analysis, conclusions, and recommendations. Actual aircraft structural samples containing fatigue damage were transported to 21 different Air Force bases and depots, where approximately 300 Air Force technicians performed ultrasonic, eddy current, penetrant and radiographic nondestructive inspections (NDI) on the samples. The same detailed NDI procedures were followed by all participating technicians. The individual results were recorded and accumulated in terms of "finds," "misses," and "false calls" compared to a preliminary knowledge of actual flaw locations. A detailed teardown inspection of the samples at the end of the program verified and refined actual flaw tabulations. Results were computerized for data storage and retrieval and analyzed for each NDI method and structure sample type to provide detection probability versus flaw size (Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. B. Boisvert **Address:** Air Force NDI Program Office MMETP Kelly AFB, San Antonio, TX **Telephone:** **Autovon** 945-8735 **Commercial** (512) 925-8735		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Processes **Date:** August 1979

Title: Reliability of Nondestructive Inspections; AD-A072097

Synopsis:

The results of a four-year Air Force Logistics Command program to determine the reliability of Air Force nondestructive inspection capability are presented in report AD-A072097. The report completely describes the *program* - its objectives, scope, planning and logistics, participants, data collection, analysis, conclusions, and recommendations. Actual aircraft structural samples containing fatigue damage were transported to 21 different Air Force bases and depots, where approximately 300 Air Force technicians performed ultrasonic, eddy current, penetrant and radiographic nondestructive inspections (NDI) on the samples. The same detailed NDI procedures were followed by all participating technicians. The individual results were recorded and accumulated in terms of "finds," "misses," and "false calls" compared to a preliminary knowledge of actual flaw locations. A detailed teardown inspection of the samples at the end of the program verified and refined actual flaw tabulations. *Results were computerized* for data storage and retrieval and analyzed for each NDI method and structure sample type to provide detection probability versus flaw size (Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. B. Boisvert **Address:** Air Force NDI Program Office MMETP Kelly AFB, San Antonio, TX **Telephone:** **Autovon** 945-8735 **Commercial** (512) 925-8735		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

Title: Reliability of Nondestructive Inspections

Synopsis: (Continued)

(POD) curves. Other analyses provide POD curves for years training, experience, age, etc.

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Processes **Date:** August 1979

Title: Primary Adhesively Bonded Structure Technology (PABST)

Synopsis:

Air Force Flight Dynamics Laboratory (AFFDL) tests indicate that adhesive bonding could replace riveting as the usual way to assemble aircraft. An adhesively bonded aircraft weighs 15% less and costs 20% less to build and maintain. Tests have been successful to date. The glue is epoxy and is made by American Cyanimide Company.

Because of reduced removal and replacement times versus rivets and reduced machining requirements, maintenance requirements for adhesively bonded structures are reduced. In addition, the adhesive provides an airtight seal against the environment, minimizing the effects of corrosion, thus improving reliability. The reduced weight of the adhesive structure also reduces stresses, improving aircraft life.

PREVIOUS APPLICATION		
System	**Equipment Type**	**Applicability**
Aircraft	YC-14, YC-15	● Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Air Force Flight Dynamics Lab **Address:** Wright-Patterson Air Force Base Dayton, OH 45433 **Telephone:** **Autovon** 785-5407 **Commercial** (513) 255-5407		● Conception ● Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Processes **Date:** August 1979

Title: Weldbonding

Synopsis:

Weldbonding is a construction technique which combines adhesive bonding and spot welding. The process involves cleaning, adhesive application, spot welding, and curing.

After several years of development effort, this technique is to be used to fabricate five doors (inspection panels) on production models of the A-10 aircraft. It is anticipated that a 15 percent weight reduction and 20 percent maintenance cost saving will be realized through application of this technique versus more conventional techniques. It is anticipated that this technique could be applied to other structural processes that currently involve riveting.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Fuselage	A-10	○ Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Air Force Flight Dynamics Lab. **Address:** Wright-Patterson Air Force Base Dayton, Ohio 45433 **Telephone:** **Autovon** 785-5407 **Commercial** (513) 255-5407		○ Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Processes **Date:** August 1979

Title: Design and Fabrication of Investment Cast TOW Flight Motor Aft Cases

Synopsis:

TOW flight motor aft cases were designed, fabricated, evaluated, and delivered utilizing vacuum investment castings of 250 grade 18% nickel manganese steel. Thirty preforms were cast, and twenty of the castings were machined to the final print configuration. One preform having a wall thickness less than 50% of print requirements was hydrotested, meeting the minimum burst requirements of 3600 psig. Cast specimens representative of the cast preforms were evaluated for metallurgical, chemical, mechanical, and fracture toughness properties and compared to wrought 250 grade manganese steel. A specification for vacuum investment cast 250 grade manganese steel was developed following the format of MIL-S-46850.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
T.O.W.	Motor Case	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. F. L. Banta **Address:** United Technology Center Sunnyvale, CA **Telephone:** **Autovon** **Commercial** (408) 739-4880		○ Conception ● Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Processes **Date:** August 1979

Title: Brazing Stainless Steel

Synopsis:

NASA has found that reliable nonleading joints can be ensured by controlling the outgassing during brazing. An improved vacuum retort system was developed that reduces the vaporization of braze-alloy and components and results in a significant improvement in the brazing quality. Use of Argon at a constant pressure and prevention of contamination by using a valved sensor in the vacuum-control system have resulted in increased reliability of this process.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: John T. Wheeler **Address:** Lyndon B. Johnson Space Center Code AT3 Houston, TX 77058 **Telephone:** **Autovon** **Commercial** (713) 483-3809		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Processes **Date:** August 1979

Title: Gear and Bearing Manufacturing

Synopsis:

The use of materials which are free of extraneous matter can lead to a significant improvement in reliability of gears and bearings. Helicopter drive systems incorporating gears and bearings manufactured from consumable electrode vacuum-melt or vacuum-degassed steels have shown improved reliability through having fewer inherent defects than materials made using other conventional processes.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Drive System	Helicopter	● Reliability ● Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. Scharpf **Address:** AVRADCOM Applied Technology Laboratory Ft. Eustis, VA 23604 **Telephone:** **Autovon** 927-5620 **Commercial** (804) 878-5620		○ Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Processes **Date:** August 1979

Title: Flexible Interface Between Unlike Materials

Synopsis:

Dow Corning 738 RTV silicone adhesive/sealant has been found to satisfy a requirement for flexible seal between dissimilar materials which demonstrate markedly different expansion and contraction rates. This material produces no undesirable by-products while curing, remains flexible, and provides a long-lasting seal. The results of using this material have been the improved reliability and longer life of the seal, enhancing overall system reliability.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Avionics	DH-841V Horizon Indicator	● Reliability ● Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: **Address:** Bendix Corporation Navigation and Control Division South Montrose, PA 18843 **Telephone:** **Autovon** **Commercial** (717) 278-1161		○ Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Processes **Date:** August 1979

Title: Sealing Against Sand

Synopsis:

To improve the operational reliability of small intricate mechanical components which were binding due to sand ingestion, it has been found that hermetic sealing was the only method to prevent ingestion of small particles.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Components	Circuit Breakers	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. Scharpf **Address:** AVRADCOM Applied Technology Laboratory Fort Eustis, VA 23604 **Telephone:** **Autovon** 927-5620 **Commercial** (804) 878-5620		○ Conception ○ Validation ○ Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Processes **Date:** August 1979

Title: Reliability of Wire Connections; NASA Report SP-5107

Synopsis:

NASA has developed laser wire strippers for production operations that allow the insulation to be ablated and leave the stripped wire completely undamaged. Various equipments, techniques, and applications of this process are described in NASA Report SP-5107, "Selected Developments in Laser Wire Stripping." This technique will eliminate current quality control problems associated with nicked, scraped, or cut conductors and will enhance the reliability of system wiring.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: John T. Wheeler **Address:** Lyndon B. Johnson Space Center Code AT3 Houston, TX 77058 **Telephone:** **Autovon** **Commercial** (713) 483-3809		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Processes **Date:** August 1979

Title: Applications in Computer-Aided Design and Numerical Control Manufacturing Using Automated Drafting and Digitizing

Synopsis:

The study considers an automated drafting and digitizing system for the Army Materiel Command (AMC). This system was to be tested for its capability in preparing concept, experimental prototype, and production drawings. The system was also studied for its capability of producing numerical control (N/C) tapes through a digitizing process for production of limited quantity spare repair parts and (RDTE) prototype items. In exploring the equipment, the system was found to have an extremely high potential in the making of drawings, producing and verifying N/C tapes, performing engineering calculations, and manipulating numerical data into various graphic forms. The study report contains various examples and illustrations that have been produced by the automatic drafting and digitizing system. The accomplishments achieved through the use of this equipment have resulted in a significant cost reduction. It is, therefore, concluded that this project has been highly successful, and the purchase of such equipment is highly recommended to other government agencies to help reduce long engineering lead times and achieve substantial cost savings.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. V. R. Pearl **Address:** Edgewood Arsenal Edgewood, MD **Telephone:** **Autovon** 584-2011 **Commercial** (301) 671-2011		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Processes/Structural **Date:** December 1980

Title: Design Guidelines for Prevention of Corrosion in Tactical Vehicles

Synopsis:

TACOM has developed a corrosion prevention handbook for use on the design of tactical vehicles which contains detailed guidelines for the application of protective coatings, corrosion-resistant alloys, surface treatments, and structural design/assembly concepts. While the handbook addresses tactical vehicles, the presented principles and design concepts are adaptable to general military hardware. Unlike many handbooks which do not address specific design applications, each major vehicular structural area (e.g., fenders, wheel wells) is discussed in detail. Potential problems, proven/preferred design, and corrosion prevention approaches are identified.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Tactical Vehicles		● Reliability ● Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Joseph Kwaselow **Address:** Commanding General U.S. Army Tank-Automotive Command Attn: DRSTA-GSP **Telephone:** Warren, MI 40890 **Autovon** 273-2267 **Commercial** (313) 573-2267		○ Conception ○ Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Fluid Systems **Date:** August 1979

Title: Variable Fill Fluid Coupling Fan Drive; AD-A070767

Synopsis:

A variable fill fluid coupling (VFFC) fan drive with electronic speed control has been developed for the M113A1E1 Test Rig Vehicle. This system provides improved cooling and maintains more consistent coolant temperature, thereby improving the engine's operation and life expectancy. The electronic control adjusts fan speeds to prevent over speed and maintain minimum speed at low engine speeds.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Vehicles	M113A1E1	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. A. M. Loss **Address:** FMC Corp. Ordinance Engineering Div. **Telephone:** San Jose, CA **Autovon** **Commercial** (408) 289-0111		○ Conception ○ Validation ○ Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Fluid Systems **Date:** August 1979

Title: A Sliding Seal for Ultra-High Vacuum

Synopsis:

A seal was developed which allows for rotation of the entire flanges at the vacuum/air interface. Feedthroughs of any sort may be mounted on the flange, whereby any required flexible connections can be transferred to the outside of the vacuum chamber.

PREVIOUS APPLICATION		
Systems	Equipment Type	Applicability
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		Life Cycle Phase
Name: Mr. R. P. Merrill Address: Dept. of Chemical Engineering California University Berkeley, CA Telephone: Autovon Commercial (415) 642-6000		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Fluid Systems **Date:** August 1979

Title: Bi-Directional Filters

Synopsis:

Bi-directional filtration is embodied in a single compact housing which contains four dual-operating coaxial poppet valves that direct the outside to inside flow. Filter housing components are rated for 6000 psi and incorporate dirty element warning indicators. The use of bi-directional filters reduces the number of components and the complexity of fluid systems, improving the reliability and maintainability characteristic of the system.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: **Address:** Pall Corporation Glencove, NY **Telephone:** **Autovon** **Commercial** (516) 671-4000		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Fluid Systems **Date:** August 1979

Title: The Design and Calibration of Capacitance Transducers

Synopsis:

The development, calibration, and evaluation of capacitance type motion transducers for the measurement of microinch magnitude clearance through an oil film dielectric was undertaken in the study of mechanical face seals. The calibration was made under simulated conditions in a static test facility, and the evaluation was based upon anticipated performance under dynamic conditions.

PREVIOUS APPLICATION		
System	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. S. T. Myrick **Address:** Department of Mechanical & Aerospace Engineering Tenn. University **Telephone:** Knoxville, TN **Autovon** **Commercial** (615) 974-5115		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Fluid Systems **Date:** August 1979

Title: Pressure Sensors

Synopsis:

Significant improvement in the performance and reliability of pressure sensors has been achieved recently. These achievements have occurred in aircraft and space applications, but have potential for other applications. The replacement of mechanical linkages and bellows with direct electrical output signal devices has made this improvement possible. The devices can improve on a systems reliability because the mechanical linkages and bellows are more susceptible to wear and leakage than the electrical sensors. The maintenance time would be reduced because the electrical sensors are not as difficult to calibrate as the mechanical devices.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Sensing	F-15 F-16	● Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. Bair **Address:** Directorate of Engineering Wright-Patterson Air Force Base Dayton, Ohio **Telephone:** **Autovon** 785-4752 **Commercial** (513) 255-4752		◐ Conception ○ Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Fluid Systems **Date:** August 1979

Title: Anti-Chafe Hose

Synopsis:

The feasibility of a flexible high-pressure fluid hose with an internal elastomeric chafe guard has been demonstrated. The built-in chafe guard provides a ten-fold increase in the mean time between failures (MTBF) of the new hose as compared to similar, unprotected hoses. Testing was conducted under chafing conditions at -65°, + 450°F, and results showed no sacrifice of other performance characteristics.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Hose		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. Scharpf **Address:** AVRADCOM Applied Technology Laboratory Fort Eustis, VA 23604 **Telephone:** **Autovon** 927-5620 **Commercial** (804) 878-5620		○ Conception ○ Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Fluid Systems **Date:** August 1979

Title: Failure Identification Through Oil Debris Monitoring

Synopsis:

An improved method of identifying impending engine failures has been developed using fine filters (3 micron) and chip collectors. This combination has shown to be superior to the existing Spectrometric Oil Analysis Program (SOAP) in identifying impending failures and minimizing false removals.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Engines	T700	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. Scharpf **Address:** AVRADCOM Applied Technology Laboratory Fort Eustis, VA 23604 **Telephone:** **Autovon** 927-5620 **Commercial** (804) 878-5620		○ Conception ○ Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Fluid Systems **Date:** August 1979

Title: Hydraulic System RAM Investigation

Synopsis:

A reliability research program for parts storage was performed at the U.S. Army Missile R&D Command. It consisted of data collection and special testing to analyze missile hydraulic system failure characteristics. Included in the effort was an analysis of hydraulic system components (pump, actuator, valves, cylinders, filters, fluids, fittings, etc.) Typical failure modes included fluid leakage, dirt contamination, vibration wear effects, and misalignment of mechanical parts. Design approaches were evolved to combat these failure mechanisms. Use of the available information and the design approaches identified should be considered for improved equipment RAM characteristics.

PREVIOUS APPLICATION

Systems	Equipment Type	Applicability
Hydraulic System	Missiles	● Reliability ○ Availability ○ Maintainability

Point of Contact		Life Cycle Phase
Name:	Mr. D. R. Provence	○ Conception ○ Validation ● Full Scale Development ● Production and Deployment
Address:	U.S. Army Missile Command DRMI-QS Redstone Arsenal, Ala. 35809	
Telephone:		
Autovon	746-3235	
Commercial	(205) 876-3235	

AD-A096 896 ARINC RESEARCH CORP ANNAPOLIS MD F/G 5/2
RELIABILITY, AVAILABILITY AND MAINTAINABILITY DESIGN PRACTICES --ETC(U)
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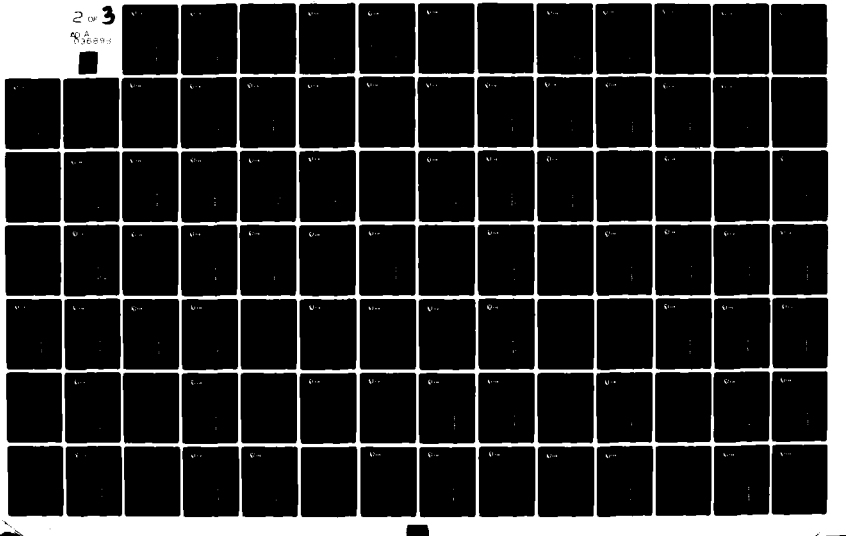

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Fluid Systems **Date:** August 1979

Title: Reliability, Maintainability, and Performance Issues in Hydraulic System Design; USAAMRDL-TR-77-6

Synopsis:

This program was conducted to compare an Advanced Conventional Pressure (ACP) 3000-psi helicopter hydraulic system to a Very High Pressure (VHP) 8000-psi system in terms of benefits, drawbacks, and development requirements. The work included the assessment of the state of the art of helicopter hydraulic systems, the development of an evaluation methodology, and the selection of a helicopter to serve as a baseline and as a vehicle for the ACP and VHP designs. Feasibility of using VHP over ACP designs was established.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Hydraulic		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. T. Geoffroy **Address:** AVRADCOM St. Louis, MO 63166 **Telephone:** **Autovon** 693-1575 **Commercial** (314) 263-1575		○ Conception ○ Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Fluid **Date:** November 1980

Title: Evaluation of a Lip-Seal Hydraulic Fitting for the F-14 Aircraft; NADC-77292-60; AD-A051159

Synopsis:

NADC evaluated a lip-seal hydraulic fitting for possible use on the F-14 aircraft. The fitting was a new type manufactured by the Titeflex Company of Springfield, Massachusetts. Three samples of 6mm, 9m, 13mm, and 25mm were tested in accordance with MIL-F-18280 and Grumman Aerospace Company specification SP-G-017A.

A summary of those tests is as *follows*:

- Proof and Burst-After impulsing, the fitting must function to 6000 psi. At 12,000 psi, the fitting must not leak, crack, or blow off the tube.
- Impulse testing-Subjected to 200,000 cycles at 4,500 psi with a rate of rise of 321,000 psi per second.
- Flexual Strength-$1X10^7$ cycles at various stress levels with the samples pressurized to 3,000 psi.

(Continued)

PREVIOUS APPLICATION

Systems	Equipment Type	Applicability
Hydraulic	F-14	● Reliability ○ Availability ○ Maintainability

Point of Contact		Life Cycle Phase
Name:	D.O. Bagwell	○ Conception ● Validation ● Full Scale Development ● Production and Deployment
Address:	Aircraft ar . Crew Systems Technology- irectorate Naval Air De elopment Center Warminster, Pennsylvania 18974	
Telephone:		
Autovon	441-2574	
Commercial	(215) 441-2574	

Title: Evaluation of a Lip-Seal Hydraulic Fitting for the F-14 Aircraft; NADC-77292-60 ; AD-A051159

Synopsis: (Continued)

. Repeat assembly - Two samples of each size were reassembled eight times each.

All tests were passed. While being considered for use with the F-14 it was determined that the fitting is compatible with the Resistoflex and Dynatube connector being considered for the F-18 and AV-8B.

Related reports which document NADC evaluations of new hydraulic system components include:

1. "Evaluation of Brazed Permanent and Welded Separable Type Connectors and Titanium Tubing for Use in Lightweight Hydraulic Systems (LHS), 8000 psig"
   NADC-76067-30, 7 June 1976
   AD-B013194L
   J. H. Dever
   NADC

2. "Evaluation of Hydraulic Self-Aligning Metal Lip Seal Fittings"
   NADC-76213-30, 16 June 1976
   AD-B012515L
   D. O. Bagwell
   NADC

3. "Titanium Tubing and High Pressure Hoses for Lightweight Hydraulic System (LHS) 8000 psi"
   NADC-79264-60, 25 February 1980
   AD-B047895
   J. H. Dever
   NADC

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Fluid Systems **Date:** December 1980

Title: Flared-Tube Attachment Fitting; NASA Tech Briefs, Summer 1980, Vol. 5, No. 2; Technical Support Package MSC-18416

Synopsis:

NASA has developed a new flared-tube attachment fitting (U.S. Patent No. 3,689,110) for use on board the first space shuttle vehicle. The new fitting differs from those currently utilized through the use of a split ferrule. Also, the flared end of the tube is smaller than the inside diameter of the attaching nut; therefore, both the ferrule and attaching nut can be assembled onto the tube after flaring.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Spacecraft	Space Shuttle	○ Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: J. T. Wheeler **Address:** Lyndon B. Johnson Space Center Code AT-3 Houston, TX 77058 **Telephone:** **Autovon** **Commercial** (713) 483-3809		○ Conception ○ Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** August 1979

Title: Improved Bonding of Honeycomb Panels

Synopsis:

One of the major problems in the fabrication of structures from honeycomb panels, fiber-reinforced composites, foam panels, or similar materials is the joining of the panels. Bolts and rivets produce weak points near or at the joints, and adhesive bonding is an expensive labor-intensive process.

A simple and inexpensive technique, using angular metal braces bonded onto the panels, can lower the cost of construction while increasing the reliability of the joint. The braces may be made in various shapes, depending on the panel size and the angle at which they are to be joined.

This technique has been used to join the floor panels for large platforms. It was found to improve the overall reliability and structural strength, lower assembly time, and reduce construction costs.

PREVIOUS APPLICATION		
System	Equipment Type	Applicability
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		Life Cycle Phase
Name: Mr. J. T. Wheeler **Address:** Johnson Space Center Houston, TX 77058 **Telephone:** **Autovon** **Commercial** (713) 483-3809		○ Concepting ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** August 1979

Title: Extruded Edge Members for Honeycomb

Synopsis:

Edge members in bonded honeycomb panel structures are conventionally made by machining channels in aluminum bars. The open ends are stuffed with honeycomb core, using an intumescent adhesive. A less expensive technique for manufacturing these hollow extrusion-edge members eliminates the need for stuffing. Furthermore, the extruded edges are more reliable, lighter, and easier to install.

The advantages of the hollow members are:

- Core splicing and associated time-consuming steps no longer required.
- A two-stage bond sequence is used instead of the more costly three-stage sequence.
- Material and machining costs are reduced.

(Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. J. T. Wheeler **Address:** Johnson Space Center Houston, TX 77058 **Telephone:** **Autovon** **Commercial** (713) 483-3809		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

Title: Extruded Edge Members for Honeycomb

Synopsis: (Continued)

Hollow complex shapes of this type had not been used previously as edge members in primary structures because of the small circumscribing-hole diameter, complex shape, and relatively small hollow.

The new manufacturing method, however, may prove useful in fabricating structures such as airframes, vehicle frame members, and the like in which weight savings is a primary goal.

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** August 1979

Title: Aluminum Rolling Helix Crash Energy Absorber

Synopsis:

Various aluminum alloy wires suitable for a rolling helix energy absorber strut (TOR-SHOK) were investigated and evaluated for use in crashworthy troop seats. Linear stroking distance as related to break points and compatibility between the vertical wires and 6061-T6 aluminum tubes used as struts were the main test criteria. The units were subjected to environmental tests per military standard 810B and statically tested after the environmental tests.

The study indicated that 5056-H38 aluminum series wire is most compatible with 6061-T6 aluminum struts.

PREVIOUS APPLICATION		
System	Equipment Type	Applicability
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		Life Cycle Phase
Name: Mr. B. Mazelsky Address: ARA Inc. West Covina, CA Telephone: Autovon Commercial (213) 331-5301		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** August 1979

Title: Cartridge Life Extension

Synopsis:

A recent study has shown that the installed operational life of impulse guillotine cartridges, M520, can be extended from 30 months to 36 months. This study determined that there are no harmful operational reactions from this change. After evaluation, it may be possible to extend the operational life of other similar cartridges.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Cartridges	M520	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. C. C. Sun **Address:** Naval Ordnance Station Indian Head, MD **Telephone:** **Autovon** 364-4000 **Commercial** (301) 743-4000		○ Conception ○ Validation ○ Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** August 1979

Title: Super Hard Transparent Coatings

Synopsis:

A program at the Applied Technology Laboratory in Ft. Eustis involves the investigation of transparent hard coatings which can extend the service life of helicopter windshield glazings. Helicopter glazings have been particularly susceptible to damage from wiper abrasion and dust particles generated by the rotor vortex. Resurfacing the glazings with this super hard transparent coating may solve the abrasion problem and consequently reduce the need for frequent replacements of helicopter windshields and make them more reliable. This has potential applications in other areas where a surface or glass area must be protected from blowing dirt and similar abrasives and where frequent removals or repairs are currently being experienced.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Helicopters	Windshield Glazings	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. Scharpf **Address:** Applied Technology Laboratory Fort Eustis, VA 23604 **Telephone:** **Autovon** 927-5620 **Commercial** (804) 878-5620		○ Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** August 1979

Title: Screw Fasteners

Synopsis:

Designs should incorporate screws with one type of head. Type and size should be compatible with the standard tool set issued to maintainers of equipment. This practice enhances maintainability by standardizing and minimizing the tools required for maintenance and reduces the maintenance time associated with finding and changing tools. This practice should extend to use in bolts, nuts, and other fasteners.

Further guidance can be found in MIL-HDBK-759, "Human Factors Engineering Design for Army Materiel," and MIL-STD-1472, "Human Engineering Design Criteria for Military Systems, Equipment and Facilities."

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: **Address:** **Telephone:** **Autovon** **Commercial**		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** August 1979

Title: An Evaluation of the Reliability of Instrumented Charpy Test Records

Synopsis:

The shortcomings of various experimental techniques associated with the production of reliable instrumented Charpy test records were examined for the case of materials which show substantial ductility prior to fracture. A simple procedure for calibration and testing which avoids these problems and has direct relevance to fracture toughness properties was developed.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. C. Barnes **Address:** Material Research Labs Maribyrong, Australia **Telephone:** **Autovon** **Commercial**		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** August 1979

Title: Baseplate Design and Performance; AD-B0217036

Synopsis:

The results of field test programs conducted to evaluate the performance of several prototype baseplates on sand and clay soils are presented. One test series was performed to develop a possible alternative baseplate for the 60 mm lightweight company mortar system (LWCMS). Three prototype baseplates were used in this series, which resulted in design recommendations for a very lightweight, three-spade baseplate for use with the LWCMS. Another part of the program consisted of designing and testing a prototype baseplate for use with an improved 81 mm mortar system. Design goals, which were verified in the test program, were to provide a displacement reduction of up to 50% and substantial reductions in tilt relative to the present M3 baseplate. Results obtained using a baseplate test fixture having spades of variable depth and configuration indicated that spade depth was very important on sand but of minor influence on clay. The influence of spade depth on displacement and tilt on both three- and four-spade configurations is covered in detail in the test referenced report. Some data on the influence of socket height (Continued)

PREVIOUS APPLICATION

Systems	Equipment Type	Applicability
Mortar	60 mm LWCMS 81 mm	● Reliability ○ Availability ○ Maintainability

Point of Contact		Life Cycle Phase
Name:	Mr. G. W. Aitken	○ Conception ○ Validation ○ Full Scale Development ● Production and Deployment
Address:	Cold Regions Research and Engineering Lab Hanover, NH	
Telephone:		
Autovon	684-3200	
Commercial	(603) 643-3200	

Title: Baseplate Design and Performance

Synopsis: (Continued)

and perforation pattern on performance are also included.

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** August 1979

Title: Ship Design for Maintenance Accessibility; AD-A027235

Synopsis:

A systematic methodology for 'designing in' maintenance accessibility into the ship's design has been developed. Recent ship design projects, which have emphasized maintenance accessibility to varying degrees in the ship's design at the Naval Ship Engineering Center (NAVSEC), were analyzed. Based on the analysis, a ship design methodology for maintenance accessibility was developed and documented. It is intended that this report be used as guidance and as a baseline from which lessons learned can be continually fed back to improve maintenance accessibility in future ship acquisition programs. Guidance is provided on the maintenance accessibility responsibilities, schedule, and required tasks and funds for all phases of ship system design, i.e., conceptual design, preliminary design, and contract design.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. S. P. Light **Address:** Defense Systems Management School Fort Belvoir, VA **Telephone:** **Autovon** 354-6071 **Commercial** (703) 664-6071		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** August 1979

Title: Probabilistic Approach to the Design and Test of Hardened Facilities; AD-A062334

Synopsis:

In this report, the general approach to probabilistic structural design is applied to the particular case of hardened ground facilities. The basic probabilistic concepts required for design are presented and illustrated by application of the methodology to the design of a composite steel/concrete liner for a deep-buried tunnel. An evaluation of the advantages and disadvantages of the probabilistic approach compared to the deterministic approach is made.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. D. H. Merchant **Address:** Boeing Aerospace Co. Seattle, WA **Telephone:** **Autovon** **Commercial** (206) 655-2121		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** August 1979

Title: Environmental Design Criteria and Development

Synopsis:

A tri-service effort is under way to translate environment test data into design parameters. The objective is to improve equipment reliability by applying design criteria on the basis of environmental experiences. At CORADCOM, a program has been initiated to transform the climatic test data of equipment parts provided in MIL-STD-210B into design guidelines. In this way, the design engineer will be better able to consider the effects of the environment in initial design and better anticipate performance capabilities.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Electronic		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. M. Zsak **Address:** CORADCOM Ft. Monmouth, NJ 07703 **Telephone:** **Autovon** 995-2754 **Commercial** (201) 544-2754		● Conception ● Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** August 1979

Title: Reliability Prediction of Mechanical and Structural Systems; AD-A011238

Synopsis:

Valid reliability and maintainability predictions should be based on design processes as the true determinants. Failure to do this and to develop the necessary data has resulted from a lack of understanding and liaison between analysts and designers. The first corrective step should be development of a data base, initially from design testing, then from better instrumentation of R and M testing, using design, instrumentation, and data systems skills. Design-oriented failure-mode analysis and maintainability analysis are necessary for data classification. Proper use of the data for prediction depends upon an improved understanding and liaison between analysts and designers.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. W. F. Richmond **Address:** AMSAA Aberdeen Proving Ground, MD **Telephone:** **Autovon** 283-3446 **Commercial** (301) 278-3446		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** August 1979

Title: Applications of Helicopter Mockups to Maintainability and Other Related Engineering Disciplines

Synopsis:

This study was conducted to present applications of helicopter mock-ups to the engineering disciplines involved in the design. The study report consists of a series of examples and suggestions, discussing how mockups can be used for: (1) integration and coordination between customer/contractor/subcontractor/vendor levels; (2) coordination between engineering design and support groups at the contractor level; (3) improved design and demonstration of human factors and maintainability related functions. Proper application of mockups results in a savings of time, materials, and money during the later states of development. The final outcome is a more cost-effective project.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. E. D. Haukins **Address:** Army Materiel Command Intern Training Center Texarkana, TX **Telephone:** **Autovon** 829-5351 **Commercial** (201) 838-5351		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** August 1979

Title: Design Guide for the Use of Structural Shapes in Aircraft Applications. Part I: Selection Criteria for Structural Shapes and Tubing. Part II: Manufacturing Methods for Structural Shapes and Tubing.

Synopsis:

A two-part Design Guide was compiled to provide technical information and data in the production of structural shapes and tubing for aircraft and aerospace requirements. Part I provides selection criteria for shapes and tubing based on availabilities, design tolerances, and mechanical and physical properties. Part II discusses manufacturing methods for fabricating structural shapes and tubing, namely, extrusion, drawing, and form rolling. Also, Part II reviews competitive processes for manufacturing structural type components. This Design Guide is intended to assist design engineers in assessing the availability and properties of materials being considered in new or modified aircraft and aerospace systems, and to assist potential manufacturers and suppliers in assessing equipment, tooling, and processing requirements for fabricating structural shapes and tubing. Materials for aerospace requirements covered in the document include high-strength aluminum alloys, titanium alloys, steels, superalloys, refractory metals, and beryllium.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. T. G. Byrer **Address:** Battelle Memorial Institute Columbus Labs Columbus, OH **Telephone:** **Autovon** **Commercial** (614) 424-6424		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** November 1980

Title: Base Plate Design

Synopsis:

During development of the XM736 Projectile the base plates were susceptible to shearing. The base plate was redesigned to eliminate the concentration of stress through increased radii of curvature and reducing the torsional load by keying the forward M27 canister. Although not a new concept, the XM736 experience reinforces the necessity of keyed payloads for projectiles.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Artillery	8-inch XM736	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Charles E. Hughes **Address:** Commander/Director Chemical Systems Lab, USAARRADCOM ATTN: DRDAR-CLN-D **Telephone:** Aberdeen Proving Ground, MD 21010 **Autovon** 584-2614 **Commercial** (301) 671-2614		● Conception ● Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** September 1980

Title: Combat Damage Repair - Couplings Using Shape Memory Alloys (SMA)

Synopsis:

As part of the AVRADCOM Applied Technology Laboratory's (ATL) "Combat Maintenance for Army Helicopters" Program, a contract was awarded to RayChem to investigate the use of Shape Memory Alloy in the repair of fluid lines, push-pull controls, and helicopter drive shafts. Full and C-ring couplings have been developed. Application of SMA repair couplings to fluid lines and push-pull tubes has proven successful. Due to balance and load requirements, application of the couplings to drive shafts will be limited.

ATL is investigating the use a self-contained heat cartridge. Each coupling will be issued with a heat cartridge. The user will simply position the couplings/heat cartridge on the item to be repaired and initiate the heat cartridge. Use of the heat cartridge eliminates the need for propane torches or heat guns, and also ensures a consistent application of heat to the SMA coupling.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Structural	Fluid Lines Push-Pull Control Rods Drive Shafts	○ Reliability ● Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: John Ariano **Address:** USAAVRADCOM Applied Technology Laboratory Fort Eustis, Virginia 23604 **Telephone:** **Autovon** 927-5402/5305 **Commercial** (804) 818-5402/5305		○ Conception ○ Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** November 1980

Title: Advanced Structural Repair Concepts

Synopsis:

In the past, the use of advanced structural design concepts and materials was based primarily upon performance. RAM concerns were secondary. ATL has initiated a program to develop a methodology for the assessment of RAM characteristics and of cost-effective advanced structures. The development of maintenance concepts and techniques is also a part of this effort.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Helicopter	AH-1 UH-60	○ Reliability ● Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Thomas E. Condon **Address:** USAVRADCOM Applied Technology Laboratory Fort Eustis, Virginia 23604 **Telephone:** **Autovon** 927-5402/5305 **Commercial** (804) 878-5402/5305		● Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** October 1980

Title: Prototype Installations of Communications-Electronics (C-E) Equipment in Tracked and Wheeled Vehicles

Synopsis:

Prototype installations of C-E equipment in tracked and wheeled vehicles are being made and upgraded on a continuing basis. Engineering expertise, installation drawings, and procurement parts lists are readily available.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
C-E Equipment	Tracked and Wheeled Vehicles	○ Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. William A. Poyner **Address:** Commander, CORADCOM ATTN: DRDCO-PE-ES-2 Ft. Monmouth, NJ 07703 **Telephone:** **Autovon** 992-4616 **Commercial** (201) 532-4616		● Conception ● Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN APPLICATIONS/Structural **Date:** October 1980

Title: Prototype Installations of Communications-Electronics (C-E) Equipment in U.S. Army Marine and Water Craft

Synopsis:

Prototype installations of C-E equipment in marine and water craft are being made and upgraded on a continuing basis. Engineering expertise and installation drawings are readily available.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
C-E Equipment	US Army Marine and Water Craft	○ Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. William A. Poyner **Address:** Commander, CORADCOM ATTN: DRDCO-PE-ES-2 Ft. Monmouth, NJ 07703 **Telephone:** **Autovon** 992-4616 **Commercial** (201) 532-4616		● Conception ● Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Failure Modes, Analysis/Reliability **Date:** August 1979

Title: Root Cause Analysis

Synopsis:

Root cause analysis is a failure analysis method that involves the combined effort of a diagnostic team to determine the root source and solution of a problem. In many instances, system fixes are made that cure the symptoms only; the problem later recurs because the root cause is neglected. With the root cause analysis method, the actual failure-causing item is dealt with. Implementation of this technique requires a team of engineers to collect and review all available data. Possible failure causes are then considered to produce a list of postulated modes of failure. A root cause analysis chart is filled out and continually updated. In addition, more tests and data are taken as new fault causes are identified. Through a process of elimination, the root source and solution are determined.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Missile	LANCE	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. A. Magistro **Address:** ARRADCOM/Nuclear Development and Engineering Directorate Picatiny Arsenal **Telephone:** Dover, NJ 07801 **Autovon** 880-4618 **Commercial** (201) 328-4618		○ Conception ○ Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Failure Modes **Date:** August 1979

Title: Application of FMECA

Synopsis:

A Failure Modes, Effects, and Criticality Analysis (FMECA) will identify specific components which limit the system reliability. As a result, redesign efforts are directed at the suspect components to alleviate the particular mode of failure. At TARADCOM, an FMECA of the M809PIP Program identified that the modes of failure are strongly influenced by vibration. Initial verification of the corrective actions resulting from use of the FMECA will be accomplished on the terrain simulator where the vibration environment can be duplicated.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Vehicles	M809	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Dr. W. Simkovitz **Address:** TACOM RAM Engineering Division(DRDTA-JR) Warren, Miss. 48090 **Telephone:** **Autovon** 273-2680 **Commercial** (313) 573-2860		○ Conception ● Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Failure Modes **Date:** August 1979

Title: Helicopter Secondary Structures: Failure Modes, Effects, and Criticality Analysis (FMECA)

Synopsis:

The Failure Modes, Effects, and Criticality Analysis (FMECA) has been used on various secondary structures in the S61 and S65 helicopters. Use of this method has resulted in several improvements to these systems.

The FMECA identifies every possible failure mode for each component and the effects on the component and system of such a failure. A complete FMECA includes failure causes, relative probabilities of occurrence, and possible methods of prevention or correction. The FMECA is used in system evaluations, design reviews, failure analyses, and other areas in the overall reliability program.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Helicopters	S61, S65	● Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. Scharpf **Address:** AVRADCOM Applied Technology Laboratory Ft. Eustis, VA 26304 **Telephone:** **Autovon** 927-5620 **Commercial** (804) 878-5620		● Conception ● Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Failure Modes **Date:** August 1979

Title: Mathematical Aspects of Reliability-Centered Maintenance

Synopsis:

The main purpose of this report is to provide a mathematical description of the reliability-centered maintenance program. Although a mathematical formulation may not make it any easier to implement this program, by placing it in a broader context, it is hoped to emphasize the generality of its underlying principles and encourage their application to complex systems other than commercial air fleet maintenance operations. Another purpose of this report is to provide a brief but coherent introduction to those aspects of the theory of probability necessary for an understanding of the theoretical basis for the reliability-centered maintenance program. This differs appreciably from the presentations usually found in textbooks on reliability theory. Standard treatises concentrate on the functions associated with reliability and on their analytical manipulation. Here the focus is on the underlying sets of items and events and on their mutual relationships. There are two principal reasons for this difference of approach, a difference which is in large measure fundamental to the philosophy underlying reliability-centered maintenance.

PREVIOUS APPLICATION		
System	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. H. I. Resnikoff **Address:** United Air Lines, Inc. San Francisco, CA **Telephone:** **Autovon** **Commercial** (415) 876-3131		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Failure Modes, MODELS/Reliability **Date:** November 1980

Title: TRACE - Fault Tree Computer Code Analyzes Large and Complex Systems to Identify and Eliminate Combinations of Malfunctions, Failures, and Hazards

Synopsis:

TRACE, a computer simulation technique, has been developed to analyze a fault-tree, estimate the probability of tree failure, and identify the most probable causes. The fault-tree concept, originated at Bell Telephone Laboratories, provides a systematic and logical procedure for representing the structure of a system and gives an orderly description of the various combinations of possible occurrences within a system that can result in a failure. TRACE applies the technique of importance sampling to reduce computer time requirements. The power rule is utilized for the importance sampling. This program performs a Monte Carlo simulation to identify the minimal cutsets and critical paths of a fault-tree and to estimate probabilities of fault-tree failure. The basic input events to a tree are primary and secondary component failures. The time-to-failure for a component is assumed to be a random variable with an exponential distribution. Various types of logic gates are permitted. (NASA COSMIC)

(Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Computer Software Management and Information Center (COSMIC) **Address:** 112 Barrow Hall, University of Georgia, Athens, Georgia 30602 **Telephone:** **Autovon** **Commercial** (404) 542-3265		● Conception ● Validation ○ Full Scale Development ○ Production and Deployment

Title: DESIGN/Failure Modes, MODELS/Reliability

Synopsis: (Continued)

Additional program information:

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 1,637 source statements
PRICE: Program $390.00
PROGRAM NUMBER: NUC-10402

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Fault Isolation **Date:** August 1979

Title: Computer-Generated Troubleshooting Trees

Synopsis:

A program has been developed to prepare troubleshooting trees by computer. The program uses inputs on system data flow, component reliabilities, and cost of available tests. An iterative process then selects the most efficient sequence of tests to isolate all possible faults. The program computes an index of Information Gain per Unit Cost (IGUC) for each test to develop the tree.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. W. J. Pieper **Address:** Applied Science Associates, Inc. Denver, CO **Telephone:** **Autovon** **Commercial** (303) 388-4254		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Fault Isolation **Date:** August 1979

Title: A Design Guide for Built-In-Test (BIT); RADC-TR-78-224; AD-A069384

Synopsis:

This report summarizes available information of use in designing built-in-test (BIT) capabilities in electronic systems. This report provides valuable information to the design engineer to enhance equipment maintenance requirements and should be referenced when contemplating BIT design.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		● Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. A. Coppola **Address:** Rome Air Development Center Griffiss AFB, NY **Telephone:** **Autovon** 587-1110 **Commercial** (315) 330-1110		● Conception ● Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Fault Isolation **Date:** August 1980

Title: Analysis of Fault Isolation Criteria Techniques; 1980 Proceedings Annual Reliability and Maintainability Symposium, pp 29-37; CH1513-1/80/0000-0029

Synopsis:

The paper discusses an improved approach to the development of fault isolation and troubleshooting procedures for nonavionics equipment. The procedure is called FIAT (Fault Isolation Analysis Technique) and consists of four major tasks:

- A system functional analysis
- A system failure modes analysis
- Description of fault isolation task candidates
- Review, consolidation, and editing

A data processing system based upon the PL/1 language has been developed to produce a Fault Isolation Task Candidates List and an Outline Fault Isolation Procedures List. The latter list is used as a technical writer's guide in preparing the technical manual.

FIAT has been used by Sikorsky Aircraft in actual applications. Refinements to the current algorithms are proposed. (Continued)

PREVIOUS APPLICATION

Systems	Equipment Type	Applicability
CH-54	Aircraft Nonavionics	○ Reliability ● Availability ● Maintainability

Point of Contact		Life Cycle Phase
Name:	John Ariano	○ Conception ○ Validation ● Full Scale Development ● Production and Deployment
Address:	Applied Technology Laboratory U.S. Army Research and Development Laboratory Fort Eustis, Virginia	
Telephone:		
Autovon	927-5402/5305	
Commercial	(804) 878-5402/5305	

Title: Analysis of Fault Isolation Criteria Techniques

Synopsis: (Continued)

Additional point of contact is:
Thomas N. Cook
Sikorsky Aircraft Division
United Technologies Corporation
Stratford, Connecticut

Related Technical Report:
USARTL-TR-79-21
"Analyses of Helicopter Maintenance Fault Isolation Criteria/Techniques"
T. N. Cook
Sikorsky Aircraft Corporation
October 1979

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Fault Isolation

Date: September 1980

Title: LOGMOD/SMIDS

Synopsis:

Available military data indicate that very large percentages of the LRUs and WRAs returned to intermediate/depot activities are, in fact, unjustified returns. The M-65 TOW armament subsystem has components that are falsely returned at a 60-percent-plus rate. These components are removed due to BITE indications on the aircraft and by the use of specialized test, measurement, and diagnostic equipment, when available. This high number of false returns has the following grave consequences: (1) an unnecessarily large number of spare replaceable LRUs, cards, or modules have to be in the spares pipelines, bench stocks, or depot safety stocks; (2) the workloads of intermediate and depot activities are increased; (3) the cost for the handling and transportation of spares increases as well as the likelihood of additional damage; (4) unnecessary maintenance on the weapon system occurs, which increases the likelihood of generating additional problems with the equipment; and (5) the availability of the weapon system decreases. A need exists in the Army for a method of formulating, evaluating, and verifying the software of major weapon

(Continued)

PREVIOUS APPLICATION

Systems	Equipment Type	Applicability
Electronic Electromechanical Electrohydraulic	M-65 TOW M-28 Turret	○ Reliability ○ Availability ● Maintainability

Point of Contact	Life Cycle Phase
Name: Roger Hunthausen **Address:** USAAVRADCOM Applied Technology Laboratory Fort Eustis, Virginia 23604 **Telephone:** **Autovon** 927-5402 **Commercial** (804) 878-5402	○ Conception ○ Validation ● Full Scale Development ● Production and Deployment

Title: LOGMOD/SMIDS

Synopsis: (Continued)

systems that controls the fault detection and isolation logic that is used by the BITE, ATE, and maintenance manuals of such complex equipment.

The Applied Technology Laboratory has been evaluating a concept known as LOGMOD (Logic Modeling), which appears to offer a timely and inexpensive tool that program managers can use to formulate, evaluate, and verify BITE and ATE logic for complex equipment. The concept can be applied in the early development phases of the equipment to identify and verify test point locations that can simplify BITE circuitry as well as increase its effectiveness. Fielded systems may benefit as well by incorporating the LOGMOD logic into a portable, field-use display that allows the maintenance personnel to perform function checks while the system is on the aircraft. This technique is also being evaluated by the Applied Technology Laboratory under the SMIDS (Standard Maintenance Information Display System) program. Although the architecture of a display maintenance aid is not presently defined, the logic for operating such a system has been developed by DETEX Systems, Inc., and verified by the Army. Since this logic can be effectively used with any type display system, the development of an application guide is achievable at the present time.

To date, ATL has utilized LOGMOD to model the M-65 TOW and the M-28 turret. A LOGMOD/SMIDS applications handbook is currently in preparation.

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Fault Isolation **Date:** December 1980

Title: Automatic Test Program Generation

Synopsis:

As electronic systems become more complex and technician skill level/experience is decreasing, the military is placing more reliance upon automatic test equipment for fault detection and diagnostics. To reduce development costs and increase the effectiveness (e.g., percentage of all possible faults detected and isolated to the faulty component) of the resulting diagnostic program, the Navy has initiated the Automatic Test Program Generation (ATPG) project. The objective of this project is to develop a standard algorithm with which fault detection and diagnostic programs can be automatically generated (i.e., developed on a computer without manual/human intervention) based upon topological inputs (circuit design) for the unit under test.

NAEC has several ongoing contracts under which various algorithms are being evaluated. The following reports have been generated as part of the ATPG project:

(Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Avionics		○ Reliability ● Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Richard Epstein Commanding Officer **Address:** Naval Air Engineering Center Attn: 92511RE Lakehurst, New Jersey 08733 **Telephone:** **Autovon** 624-2845 **Commercial** (201) 323-2845		○ Conception ○ Validation ● Full Scale Development ○ Production and Deployment

Title: Automatic Test Program Generation

Synopsis: (Continued)

1) "Automatic Test Program Generation (ATPG) Presentational Workshop"
20 & 21 March 1979
NAEC-MISC-92-0393
11 July 1979

2) "Navy Program Review Workshop Analog Automatic Test Program Generation," 30 January - 1 February 1980
NAEC-MISC-92-0450
21 March 1980

3) "Analog Test Program Generation Complexity Algorithm and Shop Replaceable Assembly Classification Task"
Report Number Not Assigned
30 September 1970
ManTech International Corporation

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Sneak Circuit **Date:** August 1979

Title: Sneak Circuit Analysis

Synopsis:

A sneak circuit is an undesigned and unexpected circuit which produces unwanted or unexpected results. Such an anomaly is generally difficult to identify and the troubleshooting time to identify its source is generally long. For this reason, a sneak circuit analysis should be accomplished both prior to and following prototype development.

Sneak circuit analysis is used to identify hidden electronic circuits which may induce unexpected signals. These circuits are often difficult to identify or predict. These techniques have been used in the past to identify sneak circuits with varying success. This is most useful on very complex electronic equipment.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Electronic	AN/TPQ-36	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. H. Selby **Address:** ERADCOM PM-Firefinder Ft. Monmouth, NJ 07703 **Telephone:** **Autovon** 996-5152 **Commercial** (201) 544-5152		○ Conception ○ Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Sneak Circuit **Date:** August 1979

Title: Software Sneak Circuit

Synopsis:

A technique has been developed to identify sneak circuits in oftware. The technique uses topological pattern recognition methods to identify software errors in assembler language subroutines. Software instructions are translated into electrical analogies and subjected to special network tree analysis. Preliminary testing indicates that this new technique is at least as accurate at finding faults as other methods.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. J. P. Rankin **Address:** Boeing Aerospace Co. Houston, TX **Telephone:** **Autovon** **Commercial** (713) 488-0910		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Analysis **Date:** August 1979

Title: Computer-Aided Design (CAD)

Synopsis:

The use of a computer to assist in equipment design, CAD, has shown to be especially helpful in designing electronic circuit boards. Circuit boards are extremely complex and require extreme precision in the design and layout of circuits. CAD has proved to provide improved quality of boards by optimizing layouts, avoiding path interferences, optimizing part placement, and evaluating thermal design. CAD also reduces the design, manufacture, and checking time for board production. CAD also has applications in other complex design fields.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Electronics		● Reliability ○ Availability ○ Maintainability

Point of Contact		Life Cycle Phase
Name:	Mr. H. Matsumato	○ Conception ● Validation ● Full Scale Development ○ Production and Deployment
Address:	Naval Surface Weapons Center White Oak, MD	
Telephone:		
Autovon	290-1796	
Commercial	(301) 394-1796	

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Analysis **Date:** August 1979

Title: Computer-Aided Design-Reliability (CAD-R)

Synopsis:

A program has been developed that will assist the design engineer in developing electronic circuits. Once the basic function and design have been developed, this program analyzes the design to determine thermal stress points. Layout of the circuit is altered to minimize thermal stress, with a resultant improvement in reliability.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. J. Hess, Mr. G. Newport **Address:** HQ-DARCOM, DRCQA-E 5001 Eisenhower Avenue Alexandria, VA 22333 **Telephone:** **Autovon** 284-8916 **Commercial** (202) 274-8916		○ Conception ● Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Analysis **Date:** August 1979

Title: Human Factors Engineering Considerations in Designing Naval Aircraft for Maintainability

Synopsis:

Rising maintenance costs and the necessity for increased availability have resulted in a new emphasis on maintainability as a design parameter in the acquisition of Naval air systems. Human factors engineering, traditionally considered a means of improving operator performance, is also a designer's tool for improving aircraft maintainability. Department of Defense directives mandating that all systems be designed according to specific human factors engineering and maintainability criteria confirm the necessity for including the human engineer in the designing of aircraft for maintainability. A document, "The Checklist for Human Factors Engineering of Maintainability in Naval Air Systems Design," has been developed as a tool for aircraft designers and Navy design monitors to ensure human factoring criteria have been incorporated in the maintainability of the major aircraft subsystems.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. W. E. Baumgartner **Address:** Naval Postgraduate School Monterey, CA **Telephone:** **Autovon** 878-2411 **Commercial** (408) 646-2411		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Analysis **Date:** April 1980

Title: RAM Investigation of Foreign Vehicles (RIFV)

Synopsis:

Quantitative test and evaluation of RAM characteristics is currently unattainable for foreign vehicles due to the high cost of testing and lack of spare parts. TACOM has initiated a program to close this gap by conducting a physical tear-down and limited design review of selected foreign vehicles. Findings from the design investigation of foreign vehicles were compared systematically to known design characteristics and capabilities of similar Army systems. This permitted empirical quantification of the foreign vehicle RAM characteristics. Overall, the assessment has initially resulted in:

1. Potentially valuable lessons learned from the foreign country's approach to solving design deficiencies that have application to U.S. Army problems.

2. Clues as to where the foreign vehicle's most vulnerable and

(Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Automotive		● Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Joseph J. Knofczynski **Address:** TACOM DRDTA-JR Warren, MI 48090 **Telephone:** **Autovon** 273-2863 **Commercial** (313) 573-2863		○ Conception ● Validation ● Full Scale Development ○ Production and Deployment

Title: RAM Investigation of Foreign Vehicles (RIFV)

Synopsis: (Continued)

unreliable components are and the probability of restoring the system to an operable condition under combat environment.

3. Estimation of "ball park" RAM values for the vehicle, recognizing that no statistical significance can be applied.

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Analysis **Date:** August 1980

Title: Combat Maintenance for Army Helicopters

Synopsis:

The AVRADCOM Applied Technology Laboratory has initiated a program to develop inspection criteria and quick-fix maintenance techniques to minimize aircraft downtime while ensuring air worthiness under combat conditions. The program consists of four phases:

- Component selection based upon probability of hit, mission abort, and attention kill probabilities
- Development of inspection criteria
- Review of existing maintenance procedures and repair criteria, and the development of techniques required to improve aircraft turnaround
- Development of a design methodology for future aircraft systems to improve their defer and repair capability of combat damage

To date, ATL has investigated and developed quick-fix repair techniques for the following components:

(Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Aviation	Various	○ Reliability ● Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: John Ariano **Address:** USAAVRADCOM Applied Technology Laboratory Fort Eustis, Virginia 23604 **Telephone:** **Autovon** 927-5402/5305 **Commercial** (804) 878-5402/5305		○ Conception ○ Validation ○ Full Scale Development ● Production and Deployment

Title: Combat Maintenance for Army Helicopters

Synopsis: (Continued)

- Fuel Cells
- Rotor Blades
- Fluid Lines
- Drive Shafts
- Control Linkage

} Using Shape Memory Alloy Couplings

- Structure

Programmed efforts for FY 81 include two studies to develop inspection and repair criteria for helicopter structures and an effort to investigate inspection, component finite life management, and component reject criteria.

Related Technical Reports:

USAAVRADCOM-TR-80-D-16
Advanced Structures Maintenance Concepts
T. N. Cook, et al
Sikorsky Aircraft Corporation
Stratford, Connecticut 06602
June 1980

USARTL-TR-79-18
Advanced Structures Concepts, Reliability and Maintainability/ Cost Assessments
T. N. Cook
B. F. Kay
Sikorsky Aircraft Corporation

Combat Maintenance Concepts and Repair Techniques for the AH-1S Helicopter (Structure/Airframe)
Charles Hardersen, Henry Baez
Kaman Aerospace Corporation
Old Windsor Road
Bloomfield, CT. 06002
August 1980

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Analysis, DESIGN APPLICATIONS/Structural **Date:** November 1980

Title: USAF Damage Tolerant Design Handbook: Guidelines for the Analysis and Design of Damage Tolerant Aircraft Structures, AFFDL-TR79-30-1 (REVA); AD-A078216

Synopsis:

This handbook furnished background information and justification for the requirements contained in MIL-A-83444 (USAF). For metallic structures, state-of-the-art analysis, test, nondestructive inspection and repair techniques are presented.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Aircraft Structures		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Robert M. Engle, Jr. **Address:** Air Force Flight Dynamics Laboratory ATTN: AFFDL/FBG Wright Patterson AFB, Ohio 45433 **Telephone:** **Autovon** 785-6622 **Commercial** (513) 255-6622		● Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Analysis **Date:** September 1980

Title: Predictive Stress Analysis of Tube Fired Projectiles

Synopsis:

The 2-dimensional finite element elastic-plastic computer program for axisymmetric load and geometries is the standard method of analyzing projectiles. The stresses generated by this computer program agree with test results and with the analysis performed by other agencies and outside firms using similar programs.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Projectiles		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Carl W. Larson US Army Armament R&D Command **Address:** ATTN: DRDAR-LCA-M Dover, NJ 07801 **Telephone:** **Autovon** 880-2300 **Commercial** (201) 328-2300		○ Conception ● Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Analysis, TEST/Testing Technology **Date:** September 1980

Title: Experimental Stress Analysis of Tube Fired Projectiles

Synopsis:

Techniques for obtaining accelerations and stresses on projectiles as they travel in-bore in gun tubes have been successfully utilized. High "G" accelerometers and specially mounted strain gage packages have been designed to withstand the severe gun tube environment and provide repeatable, accurate data through hard wire or telemetry data transmission.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
All Large Caliber Guns	Tanks, self-propelled howitzers, towed howitzers, recoilless weapons and mortars	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Gary E. Bubb/Richard W. Collett **Address:** US Army Armament R&D Command ATTN: DRDAR-LCA-P Dover, NJ 07801 **Telephone:** **Autovon** 880-6750 **Commercial** (201) 328-6750		● Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Analysis **Date:** November 1980

Title: Wear and Erosion Reduction

Synopsis:

Techniques for measuring the relative wear and erosion of a given propellant in a laboratory simulator have been developed and are used for ranking the erosivity of new propellants.

In addition, thermal and erosion sensors have been developed which can be inserted in a gun tube and enable the optimization of the type, quantity, and configuration of a wear-reducing additive in a given propelling charge by firing a few shots.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
All Large Caliber Guns	Tanks, self-propelled howitzer, towed howitzer, high velocity guns both direct and indirect fire	● Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Dr. Joseph A. Lannon **Address:** US Army Armament R&D Command ATTN: DRDAR-LCA-G Dover, NJ 07801 **Telephone:** **Autovon** 880-3788 **Commercial** (201) 328-3788		● Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Analysis **Date:** November 1980

Title: Hydrocode Design and Analysis of Warheads

Synopsis:

HEMP is a two-dimensional finite difference hydrocode which includes high explosive equations of state and elastic-plastic effects. It has been used as a design tool for self-forging fragment warheads for use in anti-armor munitions. By using the code to predict warhead behavior and to interpret flash radiographic data, the number of experimental iterations needed to reach a satisfactory design can be significantly reduced.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
SADARM - Artillery Sub-munition STAFF - Anti armor projectile	SELF-FORGING FRAGMENT WARHEADS	● Reliability ● Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Glenn Randers-Pehrson **Address:** US Army Armament R&D Command ATTN: DRDAR-LCA-L Dover, New Jersey 07801 **Telephone:** **Autovon** 880-2516/3653 **Commercial** (201) 328-2516/3653		● Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Analysis, TEST/Testing Technology **Date:** November 1980

Title: Aerodynamic Design and Testing of Projectiles, Missiles, and Other Ordnance Items

Synopsis:

Aerodynamic stability and flight performance analyses are conducted in the design and testing of all types of ordnance items, such as projectiles, missiles, submissiles, parachutes, Magnus rotors, bomblets, decelerators, etc. Aerodynamic coefficients are obtained through theoretical and experimental means and are used in various computer programs for the performance predictions. Subsonic, transonic, and supersonic wind tunnel facilities are available. Instrumentation is available for measurement of in-flight projectile angular motions.

PREVIOUS APPLICATION

Systems	Equipment Type	Applicability
155mm,M483A1 Proj 8",XM753 Nuc Proj 81mm Mortor Proj SADARM GATOR Mine 2.75" Rocket	Transonic Wind Tunnel Yaw Sonde Subsonic Wind Tunnel Helicopter Aircraft Dispensers Helicopter	● Reliability ○ Availability ○ Maintainability

Point of Contact

Name: A. Loeb,D.Mertz,S. Wasserman

Address: Commander
USAARRADCOM
ATTN: DRDAR-LCA-F
Dover, NJ 07801

Telephone:
Autovon 880-4904
Commercial (201) 328-4904

Life Cycle Phase

- ● Conception
- ● Validation
- ● Full Scale Development
- ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Analysis **Date:** November 1980

Title: Computer-Aided Analysis for the Design of Broad Classes of Microwave Couplers, Filters, and Transmission Lines; NRL Report 8394; AD-A088772

Synopsis:

NRL has developed a FORTRAN IV program based on equivalent charge analysis. Several directional couplers of different types have been designed and fabricated using the developed analysis technique and program.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Microwave	Coupler Filter	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: B. E. Spielman **Address:** Microwave Technology Branch Electronics Technology Division Naval Research Laboratory **Telephone:** Washington, D.C. 20375 **Autovon** 297-3308 **Commercial** (201) 767-3308		○ Conception ● Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Analysis **Date:** November 1980

Title: Tolerance Analysis Program

Synopsis:

This program can be used to determine the mean and tolerance values of an end-to-end signal chain or flow path. Unlike many tolerance determination techniques, this program does not assume the nature or shape of the individual building block or circuit element probability density functions (PDF). Instead, it takes known circuit element hardware test data, which may be in the form of a histogram or specified as a nominal value with an associated set of limits, and statistically sums the PDFs of the individual circuit elements into overall PDF for the complete end-to-end signal path. From this overall PDF, a set of limits is computed which contains a desired and preselected amount of probability included between these limits. This program is particularly well-suited for defining the tolerances to be specified in procurement or test specifications, as well as having a utilitarian value in the synthesis and analysis phases of the subsystem design process. (NASA COSMIC)

(Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Electronic		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Computer Software Management and Information Center (COSMIC) **Address:** 112 Barrow Hall, University of Georgia, Athens, Georgia 30602 **Telephone:** **Autovon** **Commercial** (404) 542-3265		● Conception ● Validation ○ Full Scale Development ○ Production and Deployment

Title: Tolerance Analysis Program

Synopsis: (Continued)

Additional program information:

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM 360
PROGRAM SIZE: Approximately 1,400 source statements
PRICE: Program $570.00 Documentation $12.00
PROGRAM NUMBER: MSC-17487

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Environment **Date:** August 1979

Title: Long-Term Dormant Storage of Microelectronic Components

Synopsis:

An analysis was conducted on the long-term dormant storage test data experimentally accumulated on two microelectronic devices. All relevant information on the experimental test program was reviewed very carefully. The existence of error sources, anomalous data, and data acquisition discontinuities were identified. The final result of the analysis was the inability to identify any aging behavior as a function of time, temperature, or operational stress.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. H. Kickhaut **Address:** EX-CAL Inc. R/M Systems Division Albuquerque, NM **Telephone:** **Autovon** **Commercial** (505) 262-1941		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Environment **Date:** August 1979

Title: Moisture and Temperature Conditions in Storage Containers in Humid Environments

Synopsis:

Investigation revealed that moisture conditions inside storage containers were influenced significantly by the materials inside those containers. With increasing temperature, the materials were found to rapidly release moisture to the container air, significantly changing the moisture content (absolute humidity) of the air and increasing the potential for water condensation when radiation cooling of the contents and walls of the container occurred. To reduce the occurrence of water damage in storage containers, the study recommends that the amount of water initially enclosed in a container be minimized by (1) pre-drying the goods to be stored, (2) pre-drying the materials (e.g., pallets and packaging material) associated with the storing of goods, and (3) closing the container in dry ambient environment. Further study of the basics of moisture migration within storage containers is ongoing.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. W. H. Portig **Address:** Army Tropic Test Center APO Miami, FL 34004 **Telephone:** **Autovon** **Commercial**		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Environment **Date:** August 1979

Title: Unattended Radar Station for Dewline Application

Synopsis:

The feasibility of implementing and maintaining a string of unattended radar stations in the Arctic was examined in this study. The study is conceptual relative to design, installation, operation, maintenance, and support of unattended stations and attendant problems such as security, reliability, maintainability, availability, and life-cycle cost. Cost drivers are identified and potential solution alternatives with recommendations presented. It was concluded that with reasonable development, economical unattended Arctic radar stations are possible.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. W. Abriel **Address:** General Electric Co. Electric Systems Div. Syracuse, New York **Telephone:** **Autovon** **Commercial** (315) 456-0123		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: DESIGN/Environment **Date:** August 1979

Title: Dynamic Loads and Structural Criteria

Synopsis:

Realistic mission profiles for six helicopter types have been developed, including: observation, utility, utility/tactical assault, attack, crane, and transport. Information included are operational data, differences from design criteria, current military and Government specifications, the intended mission assignment from a practical standpoint, and identification of critical segments and conditions using high loads, high fatigue damage, and high vibration as criteria. These profiles can be used to evaluate designs for various helicopters and missions. The information provided will help in determining the best option in simulations and provide details to assess proposed modifications or improvements.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Helicopters		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. Scharpf **Address:** AVRADCOM Applied Technology Laboratory Ft. Eustis, VA 23604 **Telephone:** **Autovon** 927-5620 **Commercial** (804) 878-5620		○ Conception ● Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability **Date:** August 1979

Title: AVRADCOM, Bayesian Model; USAAVSCOM TR75-50; AD-A018890

Synopsis:

The AVRADCOM Bayesian model is an R&M analysis technique that combines past data and engineering estimates with data from ongoing tests to generate failure projections for any system. The model has a computer program that uses inputs, including MTBF data distribution estimates, failure sampling data, test times, fail times, standard deviations, and probability distribution data. The output generated includes MTBF mean, mean percentage, and confidence levels for prior, experimental, and posterior test data distribution analyses. The AVRADCOM Bayesian model is also able to function with or without previous data inputs by exclusively utilizing current test results. This allows for fewer test hours to demonstrate reliability requirements without the need for large quantities of test data.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Engine	T700	● Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. W. Gillespie **Address:** AVRADCOM Director for Product Assurance RAM/Assessment Division **Telephone:** **Autovon** 693-1286 **Commercial** (314) 263-1286		○ Conception ○ Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability **Date:** August 1979

Title: Bayesian Interactive Graphics Reliability Assessment Procedure (BIGRAP)

Synopsis:

BIGRAP is a package of interactive graphics programs, written for use in the graphics terminal TEKTRONIX 4014 connected to the ARRADCOM CEC 6500/6600 computer configuration. This package consists of a set of intricate programs that allow a user to input component success/failure data as a Boolean expression depicting system reliability logic for the purpose of assessing system reliability. The computer converts the logic expression to an algebraic expression for the system reliability as a function of the individual component reliabilities. A Bayesian statistical algorithm is then employed to provide the user with point and confidence interval estimates of system reliability. In addition, the graphics feature of the package displays histograms and corresponding Beta distributions involved in the analysis.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Electronic		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. J. Mardo **Address:** ARRADCOM ATTN: DRDAR-QAS Dover, NJ 07801 **Telephone:** **Autovon** 880-4758 **Commercial** (201) 328-4758		● Conception ● Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability **Date:** August 1979

Title: Design for RAM-Tactical Pipeline System Evaluation

Synopsis:

This is a simulation program to investigate the effects of several variable parameters on mission reliability of a bulk liquid hydrocarbon fuel pipeline. The variable parameters are:

- Pump configuration at each station
- Mean time between failures (MTBF) of the pumps
- Mean time to repair (MTTR), including logistics delay time
- Tank storage capacity
- Design flow rate of fuel through the system
- Rate of consumption
- The portion of the tank storage to empty before restarting the pumps

(Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Pipeline Systems		● Reliability ● Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. E. Leonard **Address:** MERADCOM-PA & T Directorate Ft. Belvoir, VA 22060 **Telephone:** **Autovon** 354-5771 **Commercial** (703) 644-5771		● Conception ● Validation ○ Full Scale Development ○ Production and Deployment

Title: Design for ‹RAM-Tactical Pipeline System Evaluation

Synopsis: (Continued)

A computer simulation model was formulated to help in evaluating the effects of the different parameters on the pipeline system reliability. This model will also be used to develop and validate reliability and maintainability requirements for components of the pipeline.

System reliability was evaluated for the different sets of data which were based upon a triangular distribution for time to repair and an exponential distribution for time between failures of individual pumps. The system MTBF is used as a measure of performance of the various system designs. This is done in an effort to smooth out the effect of the early system failures where demand exceeded supply. The model assumed a constant consumption rate.

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability **Date:** August 1979

Title: Reparable Systems Reliability Method; AMSAA TR-138

Synopsis:

The reliability of a complex system that is repaired, but not replaced, upon failure will often depend on the system's chronological age. To estimate the system reliability as a function of system age, one must take into account the chronological order of the observed failures. The method of fitting a distribution function, such as the Weibull, to inter-arrival times is not appropriate because the chronological order of the failure times is often lost in the analysis.

The reparable systems reliability method estimates the system reliability as a function of system age by fitting a Weibull process (rather than a Weibull distribution) to the data. The Weibull process model takes into account the chronological order of the failures. Maximum likelihood estimates of the two model parameters are given in Reliability Analysis for Complex Reparable Systems, AMSAA TR-138, along with appropriate confidence interval and goodness-of-fit procedures.

(Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Vehicles	Tactical Wheeled Vehicles and Tank Systems	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Dr. L. Crow **Address:** AMSAA-DRXSY-RE Aberdeen Proving Grounds, MD 21005 **Telephone:** **Autovon** 283-5882 **Commercial** (301) 278-5882		○ Conception ○ Validation ○ Full Scale Development ● Production and Deployment

Title: Reparable Systems Reliability Model

Synopsis: (Continued)

This method provides improved accuracy of assessments and evaluations of complex systems yielding results that are more useful for decision-making due to the inherently accurate nature of the method over previous methods.

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability **Date:** August 1979

Title: Reliability Model Development for a Nuclear Projectile

Synopsis:

This is a model which aids the reliability evaluation and the decision-making process associated with development testing of nuclear projectiles. The model employs test results in reliability prediction. Although designed for use with a nuclear weapon system, this method is applicable to many other complex systems.

The nuclear projectile considered in the report consists of a proximity fuze, a nuclear device, a ballistic case, and a rocket motor. Although the reliability model focuses on the complex fuze and warhead portions on which concern is concentrated, a reliability block diagram for the entire projectile is presented.

The block diagram, consisting of algebraic equations, serves as an intermediate step to relate mission requirements, modes of operation, or mission profiles to the reliability model. Basic laws of probability are
(Continued)

PREVIOUS APPLICATION

Systems	Equipment Type	Applicability
Missiles (Nuclear System)		● Reliability ○ Availability ○ Maintainability

Point of Contact		Life Cycle Phase
Name:	Mr. W. Eissner	○ Conception ○ Validation ● Full Scale Development ● Production and Deployment
Address:	AMSAA-DRXSY-R Aberdeen Proving Grounds, MD 21005	
Telephone:		
Autovon	283-4064	
Commercial	(301) 278-4064	

Title: Reliability Model Development for a Nuclear Projectile

Synopsis: (Continued)

used to transform the block diagram into the reliability model. The block diagram represents elements that must function for successful system operation and defines components for system success. Varrious paths for successful system operation can be determined directly from the block diagram.

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability **Date:** August 1979

Title: Reliability and Launching Policy for a System of Satellites; AD-A064304

Synopsis:

This report analyzes the reliability of a system of satellites in which a number of satellites are launched at intervals. The system is considered operational if at least one satellite in orbit is functioning. Analytical methods were investigated for determining a launching policy which would optimize some suitable system reliability parameter, but only a near-optimal policy could be found. The equations derived provide expressions for the reliability and mean downtime of the system within each time interval between successive launches and throughout the mission. The reliability model which was used included redundancy within the satellite, a launch success reliability, and a satellite cut-off time (or end of life) due to fuel exhaustion.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Ms. T. F. Klaschlsa **Address:** Royal Aircraft Establishment Fairborough, England **Telephone:** **Autovon** **Commercial**		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability **Date:** August 1979

Title: The Availability, Reliability, and Maintainability of Redundant Systems

Synopsis:

Redundancy is widely used to enhance an overall system's effective availability, reliability, and maintainability. The application of redundancy in one of its simplest but most common forms involves systems composed of iterative subsystems. All of the subsystems, including those considered redundant, are assumed to be independent, continuously energized, and on line. Mathematical models representing the redundant system availability, reliability, and maintainability have been derived using Markov chains and matrix methods. A simple computer program was developed for the application of the derived models.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. C. Papenfull **Address:** General Electric Co. Heavy Military Equipment Div. Syracuse, NY **Telephone:** **Autovon** **Commercial** (315) 456-1234		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability **Date:** September 1980

Title: Reliability and Cost Model; TACOM TR-12365

Synopsis:

The failure distribution curve for each component of a system is estimated or determined from test data. The curves are stored in the computer and the computer assembles the system by randomly selecting components from their respective distribution curves. The cost of each component, the time to replace it, and the cost to replace it are also stored in the computer.

The computer "runs" the system for its life cycle and logs each failure and cost and time to replace each component.

The program allows the user to incrementally increase the reliability of a component to determine the effect on system reliability and the decrease in life-cycle cost.

The Program is in FORTRAN and is documented in TACOM Technical Report Number 12365.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Tank Tracks	T142 Track	● Reliability ● Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Dr. Richard A. Lee **Address:** TACOM Warren, MI 48090 **Telephone:** **Autovon** 273-2228 **Commercial** (313) 573-2228		● Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability, CONTRACT APPLICATIONS/ Reliability

Date: November 1980

Title: ERSION 3 Reliability Goal Status

Synopsis:

The ERSION program is basically a prediction-type program which allows the user to input component-level reliability indices and compute overall reliability values at the subsystem, system, and unit level. Basically, the program substitutes the input indices in the SCOPE (MFS-16410) generated equation for the subsystem to obtain a subsystem reliability. A set of subsystem level indices are obtained in this manner and are substituted in the associated system SCOPE equation determined by system/subsystem ID code to obtain a system reliability index. Finally, after a complete set of system-level reliability indices are generated, numbers are substituted in the SCOPE equation to produce the overall unit reliability. The program allows the user to update a previously generated data set if the only difference between what is needed and what is available from the previously data set is in the component reliabilities. In this case, the user merely codes the number of differences on the system or subsystem control card and places the new reliabilities after the basic subsystem set. The component program will apportion the new reliability to the phases (Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Computer Software Management and Information Center (COSMIC) **Address:** 112 Barrow Hall, University of Georgia, Athens, Georgia 30602 **Telephone:** **Autovon** **Commercial** (404) 542-3265		● Conception ● Validation ○ Full Scale Development ○ Production and Deployment

Title: ERSION 3 Reliability Goal Status

Synopsis: (Continued)

of operation in the same proportion as the old values were apportioned. Since phase reliabilities are assumed independent, the overall reliability is the product of the phase reliabilities. (NASA COSMIC)

Additional program information:

LANGUAGE: FORTRAN IV, H. COMPILER
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 4,007 source statements
PRICE: Program $250.00 Documentation $12.50
PROGRAM NUMBER: MFS-24121

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability **Date:** November 1980

Title: SCOPE - System for Computing Operational Probability Equations

Synopsis:

SCOPE (System for Computing Operational Probability Equations) is a system for determining the probability of success or failure for a given network. SCOPE computes from a logical block diagram, success or failure modes, success or failure equations, and probability of success or failure probability indices. SCOPE will merge a pert type path generator with an algorithm for combining failure or success modes to obtain failure or success equations. This allows the user to analyze a system's reliability. The mathematical model for the SCOPE program is based on its extension to cases of more than two events. This program could be used in industry to determine the reliability of any large network or system where the functioning of the system is dependent on each step. (NASA COSMIC)

(Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Computer Software Management and Information Center (COSMIC) **Address:** 112 Barrow Hall University of Georgia Athens, Georgia 30602 **Telephone:** **Autovon** **Commercial** (404) 542-3265		● Conception ● Validation ○ Full Scale Development ○ Production and Deployment

Title: SCOPE - System for Computing Operational Probability Equations

Synopsis: (Continued)

Additional program information:

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 5,351 source statements
PRICE: Program $760.00 Documentation $16.50
PROGRAM NUMBER: MFS-24484

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability **Date:** November 1980

Title: APRDCT - Apportionment/Prediction

Synopsis:

This is a general program which utilizes weighting, failure rates, time, reliability equations, and system contractual stage goals to establish phase-predicted indices and phase-apportioned reliabilities at the component, subsystem, and system levels. The weighting factors used in this apportionment reflect Thurstone-Mosteller weightings derived from analyses of components with respect to conditions of use, phase stress conditions, and item capabilities. The phase reliability equations are determined from phase reliability networks by a computer program called "System for Computing Operational Probability Equations" (SCOPE, MFS-24484). (NASA COSMIC)

Additional program information:
LANGUAGE: FORTRAN IV
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 4,648 source statements
PRICE: Program $560.00
PROGRAM NUMBER: MFS-24034

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Computer Software Management and Information Center (COSMIC) **Address:** 112 Barrow Hall, University of Georgia, Athens, Georgia 30602 **Telephone:** **Autovon** **Commercial** (404) 542-3265		● Conception ● Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability **Date:** November 1980

Title: Exact Minimal Path and Minimal Cut Techniques for Determining System Reliability

Synopsis:

This is a generalization of a family of techniques for determining by exact methods the probability of successfully operating a system using tree-type logical analysis of the configuration of the elements. The system is deemed to be successful if a path of unbroken strings of connected branches corresponding to operating elements and assemblies can be traced from one end of the tree to another. The minimal paths are a subset of the paths and generate all the others; the minimal cuts are the subset of the failure states that generate all the others. The reliability of the system is the probability that at least one path obtains failure (success). The unique feature of these techniques is that one can find the system reliability if only either set of minimal states is known. By a recursive process, a system reliability (or unreliability) equation is generated as a function of the reliabilities (unreliabilities) of the elements using the complete set of minimal paths (cuts). The system reliability (unreliability) is formed by substitution into this equation. (NASA COSMIC)

(Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Computer Software Management and Information Center (COSMIC) **Address:** 112 Barrow Hall, University of Georgia, Athens, Georgia 30602 **Telephone:** **Autovon** **Commercial** (404) 542-3265		● Conception ● Validation ● Full Scale Development ○ Production and Deployment

Title: Exact Minimal Path and Minimal Cut Techniques for Determining System Reliability

Synopsis: (Continued)

Additional program information:

LANGUAGE: FORTRAN IV (73%): ASSEMBLER (27%)
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 1,889 source statements
PRICE: Program $440.00
PROGRAM NUMBER: MFS-16499

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability **Date:** November 1980

Title: Reliability Computation from Reliability Block Diagrams

Synopsis:

This program package consists of a probability calculation program used to calculate the probability of system success from an arbitrary reliability block diagram. The class of reliability block diagrams that can be handled include any active standby combination of redundancy, and the computations include the effects of dormancy and switching in any standby systems. Four factors to be considered in calculations of this type are active block redundancy, standby block redundancy, partial redundancy, and the presence of equivalent blocks in the diagram. The probability of successful operation for a system involving active redundancy is found by using the probability tree method. The principle that is used in computing standby redundancy is simple, but difficulty occurs in applying the principle to complex circuits; methods and equations are presented in the program documentation. Partial redundancy is handled by manually setting up the problem in terms of equivalent blocks. Equivalent blocks occur when the same piece of physical hardware appears more than once in the reliability block diagram. When this happens, the program assumes that if the (Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Computer Software Management and Information Center (COSMIC) **Address:** 112 Barrow Hall, University of Georgia, Athens, Georgia 30602 **Telephone:** **Autovon** **Commercial** (404) 542-3265		● Conception ● Validation ○ Full Scale Development ○ Production and Deployment

Title: Reliability Computation from Reliability Block Diagrams

Synopsis: (Continued)

block worked in one occurrence, it will work in the other and vice versa. To accommodate storage capacity (on the UNIVAC 1108), the following program limitations exist: (1) maximum of 50 blocks to a block diagram, (2) maximum of 200 success paths, (3) there can only be one output block, and (4) maximum of 14 inputs and 14 outputs per block. (The first three restrictions can be overcome by grouping blocks and/or success paths, by routing output blocks through one final success block.) The program is written to be used on a UNIVAC 1108 time-sharing system with 65K core storage and a UNIVAC 1108 FORTRAN V compiler. The program can be run in either batch or interactive mode. (NASA COSMIC)

Additional program information:

LANGUAGE: FORTRAN
MACHINE REQUIREMENTS: UNIVAC 1100 Series
EXEC 8
PROGRAM SIZE: Approximately 4,756 source statements
DISTRIBUTION MEDIA: 7 Track UNIVAC FURPUR
Formatted Tape
PRICE: Program $950.00 Documentation $6.50
PROGRAM NUMBER: NPO-13304

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability, DESIGN/Failure Modes **Date:** November 1980

Title: Failure Mode and Effects Analysis Program (FMEA)

Synopsis:

The Failure Mode and Effects Analysis Program is a tool to be utilized with a failure point summary dictionary and standard storage and retrieval routines for the purpose of maintaining a data file of reliability analyses of various designs. The primary purpose of this program is to assist in the identification and correction of failures associated with critical effects prior to design release. This program was developed for the space shuttle contract but is general enough to be adapted to any aerospace or commercial reliability activities. (NASA COSMIC)

Additional program information:

LANGUAGE: FORTRAN IV
MACHINE REQUIREMENT: IBM-360
PROGRAM SIZE: Approximately 137 source statements
PRICE: Program $430.00
PROGRAM NUMBER: MSC-17446

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Spacecraft	Space Shuttle	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Computer Software Management and Information Center (COSMIC) **Address:** 112 Barrow Hall, University of Georgia, Athens, Georgia 30602 **Telephone:** **Autovon** **Commercial** (404) 542-3265		● Conception ● Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability Growth **Date:** August 1979

Title: Reliability Growth and Demonstration Model for the XM128 Ground Vehicle Mine Dispenser

Synopsis:

Frequently, contracts include a reliability provision for a design used in building components of large mechanized equipments for the complete mechanism itself. Such provisions commonly state that a target reliability must be achieved and demonstrated by the contractor.

However, the individual items (component parts or complete mechanisms) are generally expensive, so a relatively small number of the items are funded for actual testing. In some cases, all the items may be tested, failures that occur may be analyzed, and design changes made which are intended to remove the causes of the observed failures. If no more items are available for testing, then the actual achieved reliability of the changed design cannot be estimated from the test results, and yet the contractor would like to take advantage of any improvements in reliability which his changes may have effected.

(Continued)

PREVIOUS APPLICATION

Systems	Equipment Type	Applicability
Vehicles	XM128 Ground Vehicle Mine Dispenser	● Reliability ○ Availability ○ Maintainability

Point of Contact		Life Cycle Phase
Name:	Mr. H. Lazar	○ Conception ○ Validation ● Full Scale Development ○ Production and Deployment
Address:	Product Assurance Directorate ARRADCOM Dover, NJ 07801	
Telephone:		
Autovon	880-5776	
Commercial	(201) 328-5776	

Title: Reliability Growth and Demonstration Model for the XM128 Ground Vehicle Mine Dispenser

Synopsis: (Continued)

A technique was developed that tracked reliability growth on the basis of data observed during development testing and determined at any stage the extent to which further testing was required to demonstrate the target reliability.

Using this technique, available testing data provide a continuing view of the equipment's reliability characteristics and allow management decisions with appropriate test data estimations.

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability Growth **Date:** August 1979

Title: A Reliability Growth Model Involving Dependent Components

Synopsis:

Earlier studies have shown how to convert competing risk models involving dependent random variables into models involving only independent random variables, while simultaneously preserving the distribution of the minimum and the probabilities of various failure patterns. The new methodology considers a sequence of such conversions occurring at successive points in time in which the independent random variables are becoming stochastically larger. The results obtained demonstrate that the limiting distributions in the sequence of independent models have applications in reliability growth models and in biomedical competing risk models in which the competing risks are increasing with age. In these models dependency is permitted among the random variables.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. N. Langberg **Address:** Florida State University Dept. of Statistics Tallahassee, Florida **Telephone:** **Autovon** **Commercial** (904) 644-2525		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability Growth **Date:** August 1979

Title: Reliability Growth Method

Synopsis:

A Bayesian Reliability Growth Model has been developed for one-shot items. The ability of the model to fit one-shot missile success/failure data from several MIRADCOM missiles developed over the past few years is being investigated. It will be compared to the Duane Model, a reliability growth model formulated from the Weibull method by J. T. Duane of General Electric for the Army, to determine its ability to fit past missile programs. Its sensitivity to the parameters that must be estimated at the beginning of a program will be examined and compared to other reliability models.

This model is not operational at this time but is due for completion in late FY 79 or early FY 80.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Missiles		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. Heathcock **Address:** MICOM-DRDMI-QRT Redstone Arsenal, Ala. 35809 **Telephone:** **Autovon** 746-3738 **Commercial** (205) 876-3733		○ Conception ● Validation ● Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability Growth **Date:** August 1979

Title: Reliability Growth Projection; AD-A065123

Synopsis:

This technical report presents two general procedures for projecting reliability growth. One provides for the adjustment of an actual growth curve for a similar system by the use of K-factors The other assumes the Duane reliability growth model and requires estimation of the starting point and the reliability growth constant.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. L. Nutt **Address:** MICOM Product Assurance Directorate Redstone Arsenal, AL **Telephone:** **Autovon** 746-7570 **Commercial** (205) 876-7570		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Reliability Growth **Date:** August 1979

Title: An Evaluation of Three Reliability Growth Models

Synopsis:

Three relatively simple reliability growth models for which accuracy, precision, and robustness performance were examined over a wide variety of true underlying reliability growth patterns is presented. A continuous cumulative failure rate model, a continuous instantaneous failure rate model, and a discrete reliability model, each of which employ ordinary regression methods, were evaluated using standard computer Monte Carlo simulation techniques. Simple, straightforward statistical measures of performance are exhibited in graphical and tabular form. All the models displayed some degree of difficulty in tracking particular types or portions of anomalous reliability growth patterns. The cumulative model displayed this difficulty the least and exhibited good variability (precision) performance, providing confidence in its use. The instantaneous model, while displaying generally good accuracy, exhibited poor variability performance. Except for a couple of anomalous situations, the discrete model showed good accuracy and variability performance. Forecasting performance of all the models proved to be worse than their capability to determine current reliability status.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. O. Neal **Address:** Naval Postgraduate School Monterey, CA **Telephone:** **Autovon** 878-2411 **Commercial** (408) 646-2411		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Life Cycle **Date:** August 1979

Title: Cost Optimizing System to Evaluate Reliability (COSTER)

Synopsis:

It is less expensive to improve reliability in an equipment's development phase than during subsequent phases of the life cycle. The cost incurred to achieve a particular level of reliability must be compared to the costs saved after the equipment is deployed. There would be the savings from the decreased number of failures experienced in field deployment because of improved reliability.

In order to quantitatively analyze the cost trade-off in achieving a particular level of reliability, a computerized cost model (COSTER) was developed. The model elaborates on the cost and reliability improvements resulting from six major reliability processes prior to an equipment's field deployment, which consist of:

- Design review
- Reliability prediction program

(Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Electronics	SINCGARS-V	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Ms. G. A. Marseglia **Address:** CORADCOM, DRDCO-PT-P Fort Monmouth, NJ 07703 **Telephone:** **Autovon** 995-2205 **Commercial** (201) 544-2205		○ Conception ○ Validation ● Full Scale Development ○ Production and Deployment

Title: Cost Optimizing System to Evaluate Reliability (COSTER)

SYNOPSIS: (Continued)

- Failure mode, effects, and criticality analysis (FMECA)
- Parts program, in which MIL-STD and high reliability parts are selected in place of commercially available parts
- Reliability testing programs
- Burn-in

COSTER is not a Life-Cycle-Cost Model, but is used as a comparative analysis tool for selecting the best reliability program plan and the optimal value of MTBF for the reliability specification.

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Life Cycle **Date:** August 1979

Title: Operating and Support Cost Model

Synopsis:

The PERSHING Project Office has developed an Operating and Support Cost Model to provide the capability to determine the effects of operating and support costs during the early design phase of weapon system changes. The model provides single-day turnaround for cost effects with attendant traceability as the basis for any cost changes. The most unusual feature of the model is its ability to synthesize tactical operational testing and evaluation (OT&E) that results from design of the mission-essential equipment. In addition, the maintenance portion of the OT&E is constructed on the basis of annual maintenance man-hour requirements and reliability and maintainability data.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Missile	PERSHING	● Reliability ● Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Maj. A. L. Moore **Address:** MICOM-DRCPM-PE-S Redstone Arsenal, AL 35809 **Telephone:** **Autovon** 746-1291 **Commercial** (205) 876-1291		● Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Life Cycle **Date:** August 1979

Title: The Avionics Laboratory Predictive Operations and Support (ALPOS) Cost Model

Synopsis:

Recent DoD experience shows that a prime factor in the evaluation of alternative weapon systems for performing a particular mission is Life-Cycle Cost (LCC). Since 70% of the system LCC is determined by the end of the conceptual phase, it is important that techniques to predict LCC be available during this phase. Since system definition is not complete enough in this phase to perform detailed analysis using accounting models, the major tool which can be used is parametric estimating models. The study report describes a model which relates the available design parameters to LCC via various cost estimating relationships (CERs). The Final Report describes the mathematical and statistical techniques used to obtain the cost estimating needed to develop the Avionic Laboratory Predictive Operations and Support (ALPOS) Cost Model.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. E. Feltus **Address:** Westinghouse Electric Co. Hunt Valley, MD **Telephone:** **Autovon** **Commercial** (301) 667-3227		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

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RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Life Cycle **Date:** August 1979

Title: Computer Model for Analysis of Army Aircraft RAM Improvement Proposals

Synopsis:

A computer model has been developed for preparing cost trade-off studies of RAM efforts as required by AR 702-3. The model is specifically directed to RAM efforts involving Army aircraft. It determines the total life-cycle effect of RAM effort utilizing various RAM parameters. It is a modification of an economic analysis model and is a preliminary effort to combine the methods of cost analysis and product assurance.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Aircraft		● Reliability ● Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. E. Laughlin **Address:** AVRADCOM-DRDAV-BCA St. Louis, MO 63166 **Telephone:** **Autovon** 698-6911 **Commercial** (314) 268-6911		○ Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Life Cycle **Date:** August 1979

Title: Logistics Cost Analysis Model 5

Synopsis:

Logistics Cost Analysis Model 5 is an upgraded model of maintenance policies utilized by the U.S. Army Missile Command and the U.S. Army Weapons Command. Model progression included Missile Command, Weapons Command cost analysis of maintenance policies, and Logistics Cost Analysis Models 2, 3, and 4. It is an analytical computer program capable of representing field logistic support functions and flow. It computes life-cycle costs and operational availability for alternate system support concepts. Output includes provisioning requirements and operational elements both by numbers and cost. Variable dimensions are limited only by the computer. Parameters include extensive specification of factors for deployment, equipment, supply, maintenance, and test equipment. Sensitivity to all input factors is possible.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability

Point of Contact		Life Cycle Phase
Name:	Mr. E. Seaberg	○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment
Address:	RCA Government Systems Burlington, MA	
Telephone:		
Autovon		
Commercial	(617) 272-4000	

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Life Cycle **Date:** August 1979

Title: Analytic Methodology for System Evaluation and Control (AMSEC)

Synopsis:

AMSEC is a technique developed by Cobro Corporation scientists for Army use in support of management planning of major programs. AMSEC comprises three basic components:

1. A reliability, maintainability, availability, and life-cycle support cost (RMAC) model which develops estimates of system or subsystem reliability, availability, and cost from real or postulated data describing the system design, the support parameters, and the plan for use.

2. A field data transducer routine which accepts data routinely generated by the Army and converts it to RMAC model input parameters.

3. An executive routine which directs the RMAC model in a systematic search for optimal management actions. (Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Various	M60, Blackhawk, Bell 214 CH-47D	● Reliability ● Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. T. Geoffroy **Address:** AVRADCOM-DRDAV-QR St. Louis, MO 63166 **Telephone:** **Autovon** 693-1575 **Commercial** (314) 263-1575		○ Conception ● Validation ● Full Scale Development ● Production and Deployment

Title: Analytic Methodology for System Evaluation and Control (AMSEC)

Synopsis: (Continued)

AMSEC can provide a rapid assessment of vehicle and subsystem reliability, availability, and life-cycle support cost under the present framework of design, support, and use parameters; it can search out improved maintenance plans or search through alternative product-improvement programs to select a preferred course of action; it can determine the preferred times for rebuilding major components of the vehicle or for buying new, provide estimates of optimal sparing levels for components, and recommend cost-effective routes by which to adapt to changing needs imposed by a shift from peacetime to wartime operations.

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Life Cycle **Date:** August 1979

Title: An Appraisal of Models Used in Life-Cycle-Cost Estimation for USAF Aircraft Systems; AD-A064333

Synopsis:

Although life-cycle analysis is widely used as a management tool, considerable uncertainty still exists about its effectiveness with respect to economic trade-offs, funding decisions, and resource allocations. This report (AD Number A064333) evaluates some of the most widely used life-cycle-cost (LCC) models, AFR 173-10 models (BACE and CACE), the Logistics Support Cost Model, the Logistics Composite model, the MOD-METRIC model, AFM 26-3 Manpower Standards, Air Force Logistics Command Depot Maintenance Cost Equations, the DAPCA model, and the PRICE model. The models are rated within a framework incorporating a set of life-cycle-cost elements and a set of cost-driving factors. Color-coded illustrations summarize the results. The models are shown to have many shortcomings that limit their usefulness for life-cycle analyses in which estimates of absolute, incremental cost are required. Specific areas are identified where driving factor/cost element combinations are not adequately addressed.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. K. E. Marks **Address:** Rand Corporation Santa Monica, CA **Telephone:** **Autovon** **Commercial** (213) 393-0411		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Simulation **Date:** August 1979

Title: RMS Cost Model

Synopsis:

For several years, the Army has employed the Reliability and Maintainability Simulator (RMS) computer program to simulate the operation and maintenance of helicopter fleets of up to [illegible] aircraft. However, since the basic RMS model did not include cost information, the economic consequences of changes in the maintenance procedures could not be projected, and the cost-effectiveness of contemplated reliability improvements could not be evaluated. Consequently, to remedy these deficiencies, the RMS model was revised and expanded to an RMS COST model by adding a cost computation to determine all operating and maintenance costs during the simulation period. The resultant RMS COST model was demonstrated by executing a simulation of an OH-58 helicopter company with a baseline mission and maintenance system scenario and then with six alternative scenarios.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Helicopters	OH-58	● Reliability ○ Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. L. E. Clay **Address:** Technology Inc. Instruments and Controls Div. Dayton, OH **Telephone:** **Autovon** **Commercial** (513) 224-9066		○ Conception ○ Validation ○ Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Simulation **Date:** August 1979

Title: Development Program for an Aircraft R&M Simulation Model; AD-A014102

Synopsis:

The Aircraft Reliability and Maintainability Simulation (ARMS) model was developed to analyze the capabilities and support requirements of Army aircraft. The input data (MTTR, MTBF, maintenance personnel quantities and skills, etc.) may be defined in the model at a level consistent with the user's purpose (e.g., aircraft definition at the subsystem level may be sufficient for a conceptual study, whereas an operational study would probably require an aircraft definition in greater detail). A program description is contained in the referenced report.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Helicopters	UTTAS, AAH, CH-47, HLH, OH58, UH-1H, OH-6	● Reliability ● Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: H. M. Bratt **Address:** AVRADCOM Applied Technology Laboratory Ft. Eustis, VA 23604 **Telephone:** **Autovon** 927-2770 **Commercial** (804) 878-2770		● Conception ● Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Simulation **Date:** August 1979

Title: Field Data and Model Update

Synopsis:

A model has been developed to simulate responses to anticipated jamming and search "noise" for input into a general missile operational model. The new aspect of this model is that it uses field test data to provide feedback on model performance, thus improving the model's accuracy. This technique has been used to simulate missile performance and improve operational capabilities.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. N. A. Kheir **Address:** MICOM Redstone Arsenal, AL **Telephone:** **Autovon** 746-7570 **Commercial** (205) 876-7570		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Simulation **Date:** August 1979

Title: Sequential Test Simulation Model

Synopsis:

Use of sequential test plans presents an opportunity for cost and time saving in the operation of reliability tests. The only sequential test plans available for general use are in MIL-STD-781C and MIL-HDBK-H108. Since these two sources present a limited number of test plans, the program objective was to introduce flexibility into the design and evaluation of sequential test plans which were developed by using standard or non-standard plans. Those sequential test plans have the ability to select truncation points for desired Type I and Type II risks, flexibility to permit incremental movement of boundary lines, and optional Operating Characteristics (OC) curve plots. The basic program is currently designed to be run from a remote terminal of the MERADCOM CDC 6600 computer. Actual application of the simulation awaits further development.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. Thomas Schnelle **Address:** Quality and Reliability Division Product Assurance and Testing Directorate MERADCOM Ft. Belvoir, VA 22060 **Telephone:** **Autovon** 354-5988 **Commercial** (703) 664-5988		○ Conception ○ Validation ○ Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Simulation **Date:** August 1979

Title: Monte Carlo Bayesian System Reliability and MTBF Confidence Assessment

Synopsis:

SPARCS-2 (Simulation Program for Assessing the Reliabilities of Complex Systems, Version 2) is a PL/1 computer program for assessing (establishing interval estimates for) the reliability and the MTBF of a large and complex system of any modular configuration. The system can consist of a complex logical assembly of independently failing attribute (Binomial-Bernoulli) and time-to-failure (Poisson-exponential) components, without any regard to their placement. Alternatively, it can be a configuration of independently failing modules, where each module has either or both attribute and time-to-failure components. The raw data for assessments are the component failure history data and the system configuration.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. M. O. Locks **Address:** College of Business Admin. Oklahoma State University Stillwater, OK **Telephone:** **Autovon** **Commercial** (405) 624-5064		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Simulation **Date:** August 1979

Title: FAMECE Simulation for Logical Evaluation (FACSIMILE)

Synopsis:

FACSIMILE is a model developed by AMSAA for assisting in establishing a realistic reliability requirement for the Family of Military Engineer Construction Equipment (FAMECE). FACSIMILE is written using the GASP IV simulation language. Basically, the program takes the FAMECE through a network of tasks involved in the construction of a forward area air field, using a certain set of mean time between failures (MTBF). The statistics generated are then compared with those derived from other runs using different MTBFs for the FAMECE sections.

Typical outputs are probabilities of survival, fail-free operating periods (duty cycles), mission success diagrams, and other reliability parameters that can be refined according to different MTBF requirements.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Vehicle	FAMECE	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. H. Lee **Address:** AMSAA-DRXSY-RV Aberdeen Proving Grounds, MD 21005 **Telephone:** **Autovon** 283-2682 **Commercial** (301) 278-2682		● Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Simulation **Date:** August 1979

Title: Operational Availability Inventory Model

Synopsis:

A mathematical description is given of a computer model, called the Optimal A(o) Model, designed to maximize equipment operational availability subject to a budget constraint for spares procurement. Levels are calculated for all items in the equipment parts breakdown and all activities in a multi-echelon supply/repair system. A solution procedure is given based upon the Lagrange multiplier approach with an embedded dynamic programming technique. The Material Flow Models are designed to calculate parameters of the Optimal A(o) Model.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. A. Clark **Address:** CACI Inc. Federal Systems and Logistics Div. Arlington, VA **Telephone:** **Autovon** **Commercial** (703) 841-7800		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Simulation **Date:** August 1979

Title: A Model for Predicting Integrated Man-Machine System Reliability

Synopsis:

Validation and additional sensitivity testing of a computer simulation model for predicting integrated system reliability have been completed. Integrated or total system reliability is considered to be dependent on both operator/maintainer reliability and on equipment reliability. The validation and sensitivity tests are based on the AN/SQS-26 sonar system. Both the sensitivity test data and the validation data are considered to support the intended purpose.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
SONAR	AN/SQS-26	● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. A. Siegel **Address:** Applied Psychological Services Inc Wayne, PA **Telephone:** **Autovon** **Commercial** (215) 688-4874		○ Conception ○ Validation ● Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Simulation **Date:** November 1980

Title: RAM - Reliability Analysis Model

Synopsis:

The Reliability Analysis Model (RAM) Program is an integrated Systems Design Analysis Program whose primary purpose is to combine the results of various Saturn V analyses into a single effective and comprehensive program. The RAM Program can be readily applied to determine the probability of success for one or more given objectives for any complex system. RAM can be applied to analyze complex transportation systems and traffic control systems and can be used in designing more reliable and safer automobiles. The Reliability Analysis Model Program is also applicable to urban planning, the air pollution problem, weather prediction, in determining the effect of the weather on the environment, and in determining the effect of human factors on reliability. The RAM program includes failure mode and effects, criticality and reliability analyses, and some aspects of operations, safety, flight technology, systems, design engineering, and configuration analyses. The unique advantage of this methodology and its associated programs is that the results of all these analyses are fed into a single data bank in terms (Continued)

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Missile	Saturn V	● Reliability ● Availability ● Maintainability
Point of Contact		**Life Cycle Phase**
Name: Computer Software Management and Information Center (COSMIC) **Address:** 112 Barrow Hall, University of Georgia, Athens, Georgia 30602 **Telephone:** **Autovon** **Commercial** (404) 542-3265		● Conception ● Validation ● Full Scale Development ○ Production and Deployment

Title: RAM - Reliability Analysis Model

Synopsis: (Continued)

of impact on mission objectives, so that comparison, correlation, and trade-offs may be made between the results of the various analyses. The basic output of the RAM program is the identification of those components that are critical to primary flight mission (no abort), vehicle integrity (no physical destruction of the vehicle), and crew safety. In addition to identifying those components that are critical to a specific objective, this program can rank them in order of importance (probability of primary flight mission success, vehicle integrity, and crew safety - both as an overall number and as a profile with respect to mission time). The criticality determination technique (CD technique) used in conjunction with RAM is a more general method. Criticality numbers can be assigned to components, subsystems, systems, stages, missions, and crews for any given failure distribution, such as the exponential, Weibull, Gamma, or truncated normal, where applicable. (NASA COSMIC)

Additional program information:

LANGUAGE: COBOL (100%)
MACHINE REQUIREMENTS: IBM-360
PROGRAM SIZE: Approximately 18,150 source statements
PRICE: Program $2,410.00
PROGRAM NUMBER: MFS-14513

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Simulation **Date:** November 1980

Title: SEE - Systems Effectiveness Evaluation Computer Program

Synopsis:

A system of eight integrated computer programs has been developed to assess the effectiveness of any complex electronic system. The programs were originally developed to assess the reliability and maintainability of twelve sets of Acceptance Checkout Equipment/Spacecraft ZAEC-S/C, each set containing 175 racks of equipment and 1,000 piece parts. Input to the System Effectiveness Evaluation (SEE) Programs consists of system configuration data, elapsed time meter readings and edited failure reports. The outputs of the SEE Programs are: (a) Mean Time Between Failures (MTBF) and Mean Time To Repair (MTTR) for all unique parts of assemblies, for all subsystems and for the system, with associated confidence parameters and flagging of weak links; (b) Printer-Plotter trend charts of the MTBFs and MTTRs; (c) MTBF and MTTR correlation charts comparing performance of all ground stations. (d) computation of system reliability, availability, and expected cumulative downtime during a simulated mission; and (e) numerous utility programs used in spares prediction and to assist in identification of problem areas. Proper and timely integration of three separate and distinct data areas are essential for desired results: A set of translation tables to (Continued)

PREVIOUS APPLICATION

Systems	Equipment Type	Applicability
Electronic	Acceptance Checkout	● Reliability ● Availability ● Maintainability

Point of Contact	Life Cycle Phase
Name: Computer Software Management and Information Center (COSMIC) **Address:** 112 Barrow Hall, University of Georgia, Athens, Georgia 30602 **Telephone:** **Autovon** **Commercial** (404) 542-3265	● Conception ● Validation ○ Full Scale Development ○ Production and Deployment

Title: SEE - Systems Effectiveness Evaluation Computer Program

Synopsis: (Continued)

precisely encode the complete logical description of all equipment to be assessed; systematic reporting and processing of failure experience; periodic recording and processing of equipment operating time. The primary feature of the SEE Program is the ability to rapidly pinpoint equipment problem areas for corrective action down to the lowest possible level of assembly. The programs can be modified to be utilized by any large complex electronic system. (NASA COSMIC)

Additional program information:

LANGUAGE: FORTRAN (67.65%); GMAP (32.35%)
MACHINE REQUIREMENTS: GE-635
PROGRAM SIZE: Approximately 12,175 source statements
PRICE: Program $1,000.00 Documentation $21.00
PROGRAM NUMBER: HQN-10306

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Prediction **Date:** August 1979

Title: K-Band Reliability Improvement; AD-B032853

Synopsis:

The results obtained during a three-year effort concerned with K-Band System Reliability improvement are summarized in the final report (AD Number 032853). The advanced Development Model of the K-Band System was used as a physical model to predict the availability, reliability, maintainability, and dependability that may be expected for future-generation equipment. The Battelle-developed Tabular System Analysis (TASA) technique is used for making these predictions.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. J. E. Drennon **Address:** Battelle Co. Columbus Labs Columbus, OH **Telephone:** **Autovon** **Commercial** (614) 424-6424		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Prediction **Date:** August 1979

Title: Reliability Trade-Offs for Unit Production Cost

Synopsis:

Several models have been developed for the evaluation of trade-offs in the requirement to execute specific reliability program elements, the resultant achieved reliability, and the impact upon unit production cost. The program elements considered include parts standardization, selection, and control; vendor selection, qualification, and surveillance; and screening and test programs at piece part and various assembly levels.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. T. W. Butler **Address:** Martin Marietta Aerospace Co. Orlando, FL **Telephone:** **Autovon** **Commercial** (305) 352-2000		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Prediction **Date:** August 1979

Title: Storage Reliability of Missile Materiel

Synopsis:

The Storage Reliability of Missile Materiel Program consists of the following elements: (a) gathering of storage reliability data from manufacturers, service elements, NASA, and other potential sources, on all types of missile materiel; (b) conduct of specially designed accelerated tests to generate data which do not already exist; and (c) organization and analysis of data and establishment of a storage reliability data bank at MICOM for use by all elements having a need for such information. The last objective includes generation of techniques and procedures for accurate prediction of storage reliability and identification and definition of procedures, processes, and practices which will assure high storage reliability of missile-related equipment. The Storage Reliability Data Bank has been established. The program is planned as a permanent ongoing effort with the data bank being expanded and updated on a continuing basis. The results of the program will be applied to storage reliability prediction of new Army systems as they move through the development cycle.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Missile		● Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: L. Conger **Address:** MIRADCOM-DRDMI-QS Redstone Arsenal, AL 35809 **Telephone:** **Autovon** 746-3250 **Commercial** (205) 876-3250		○ Conception ○ Validation ○ Full Scale Development ● Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Prediction **Date:** August 1979

Title: Failure Prediction Models for Wear and Fretting-Wear

Synopsis:

Failure prediction models were developed to evaluate the wear and fretting-wear failure modes of mechanical parts. Both wear and fretting-wear failures are associated with sliding and contacting surfaces. Wear causes a part to function improperly due to gradual removal of material from the contacting surfaces. Fretting-wear, on the other hand, causes local stress concentrations around the area of the mating parts, resulting in cracks and fissures.

There are three models developed: the adhesive/abrasive wear model, the zero wear model, and the linear cumulative damage model. These models can be used to anticipate failure modes and frequencies.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
Helicopter		● Reliability ● Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. R. Scharpf **Address:** AVRADCOM Applied Technology Laboratory Ft. Eustis, VA 23604 **Telephone:** **Autovon** 927-5620 **Commercial** (804) 878-5620		● Conception ● Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Prediction **Date:** August 1979

Title: Reliability Prediction Models for Microwave Solid-State Devices

Synopsis:

A program has recently been completed to develop base failure rates and failure rate mathematical models for microwave solid-state devices. These models are provided in the format of MIL-HDBK-217B. More than 8.75 billion part-hours of operating field data were collected from industrial and Government data sources. Data were analyzed and sorted manually. Conclusions are summarized in the final report as well as revised base failure rates and the mathematical models. Failure rates developed for those devices already included in MIL-HDBK-217B are compared with present failure rates. Devices not presently included in MIL-HDBK-217B are listed with new pages for inclusion in MIL-HDBK-217B.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. G. F. Guth **Address:** Martin Marietta Aerospace Co. Orlando, FL **Telephone:** **Autovon** **Commercial** (305) 352-2000		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Prediction **Date:** August 1979

Title: Optimized Reliability and Component Life Estimates (ORACLE)

Synopsis:

Through the input of an electronic parts list, the computer program ORACLE can generate many needed reliability design parameters for electronic systems. The program determines the MIL-HDBK-217C parameters and selects the proper prediction algorithm needed to calculate the part failure rate. The output lists each part and its corresponding failure rate, the sum of the failure rates for all of the parts corresponding to a system or a subsystem, the Mean Time Between Failures (MTBF) for the system or subsystem, the cost of each individual part, and the cost for the system containing the parts. ORACLE can be executed through a batching procedure or run interactively. In either case, ORACLE can perform trade-off analyses through the modification of the parts application conditions such as the operating temperature, the screening level, and the operating environment. This provides the user with a knowledge of how the system's reliability and cost will change as the application conditions are changed.

(Continued)

PREVIOUS APPLICATION

Systems	Equipment Type	Applicability
Electronic Systems	Various	● Reliability ○ Availability ○ Maintainability

Point of Contact		Life Cycle Phase
Name:	Mr. G. D. Neeman	● Conception ● Validation ○ Full Scale Development ○ Production and Deployment
Address:	CORADCOM,DRDCO-PT-P Ft. Monmouth, NJ 07703	
Telephone:		
Autovon	995-2295	
Commercial	(201) 544-2295	

Title: Optimized Reliability and Component Life Estimates (ORACLE)

Synopsis: (Continued)

The effective data base has a part count approaching a quarter of a million parts.

RAM DESIGN PRACTICES GUIDE

Key Words: MODELS/Prediction **Date:** August 1979

Title: Y/AV-8B Reliability and Maintainability Block Diagrams and Mathematical Models; AD-B033086

Synopsis:

This report (AD Number B033086) provides mission success predictions for a one-half hour close air support mission and a one-hour composite mission, and the predicted organizational and intermediate maintenance required. It also includes a definition of the mission profiles, success criteria, equipment duty cycles, failure rates, ground rules/methods, and the estimated character and magnitude of maintenance parameters and support demands.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: **Address:** Commander Naval Air Systems Command AIR-5104 **Telephone:** Washington, DC 20361 **Autovon** 222-0883 **Commercial** (202) 692-0883		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment

RAM DESIGN PRACTICES GUIDE

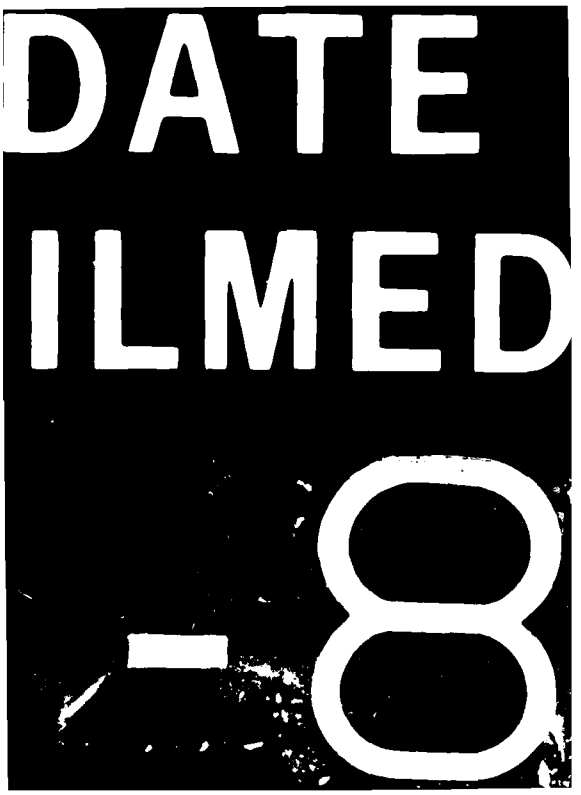
Key Words: MODELS/Prediction **Date:** August 1979

Title: A Comparison of Analytic and Simulation Reliability and Maintainability (R&M) Prediction Methods

Synopsis:

Two methods for predicting the reliability and maintainability (R&M) of systems were evaluated - a simulation method and an analytic method. Two computer programs (SIM3 and GEMJR) incorporating these methods and their input and output were assessed. The simulation method used Monte Carlo techniques in predicting reliability. The analytic method incorporated the Poisson failure process to develop stochastic matrices which can be solved using infinite series to give reliability and availability indices. The advantages and disadvantages of both methods were considered. System configuration changes and complex missions can be considered more effectively using the simulation method. However, the simulation method does not calculate availability and provides only approximate results. In contrast, the analytic method predicts exact results and can examine such maintenance aspects as repairmen, standbys, and redundancies. Both methods are useful tools depending upon the R&M applications.

PREVIOUS APPLICATION		
Systems	**Equipment Type**	**Applicability**
		○ Reliability ○ Availability ○ Maintainability
Point of Contact		**Life Cycle Phase**
Name: Mr. M. Gray **Address:** D.W. Taylor Naval Research and Development Center Bethesda, MD **Telephone:** **Autovon** 287-1291 **Commercial** (301) 227-1291		○ Conception ○ Validation ○ Full Scale Development ○ Production and Deployment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